Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

C S A S | **S C C S**

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Research Document 2012/147 | **Document de recherche 2012/147**

Gulf Region | **Région du Golfe**

Status of Atlantic salmon (*Salmo salar* L.) stocks in rivers of Nova Scotia flowing into the Gulf of St. Lawrence (SFA 18)

Etat des populations de saumon atlantique (*Salmo salar*) dans les rivières de la Nouvelle-Ecosse qui déversent dans le golfe du Saint-Laurent (ZPS 18)

C. Breau
Fisheries and Oceans Canada / Pêches et Océans Canada
Gulf Fisheries Centre / Centre des Pêches du Golfe
343 University Avenue / 343 avenue de l'Université
P.O. Box / C.P. 5030
Moncton, NB / N.-B.
E1C 9B6

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

This document is available on the Internet at

La présente série documente les fondements scientifiques des évaluations des ressources et des écosystèmes aquatiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au Secrétariat.

Ce document est disponible sur l'Internet à

www.dfo-mpo.gc.ca/csas-sccs

ISSN 1499-3848 (Printed / Imprimé)
ISSN 1919-5044 (Online / En ligne)
© Her Majesty the Queen in Right of Canada, 2013
© Sa Majesté la Reine du Chef du Canada, 2013
Canada

TABLE OF CONTENTS

ABSTRACT IV

RÉSUMÉ V

INTRODUCTION 1

ATLANTIC SALMON FISHERIES 2

First Nations fisheries 2

First Nations harvests 2

Recreational Fishery 3

Angling statistics from license stubs 3

CONSERVATION REQUIREMENTS 4

ADULT RETURNS TO RIVERS IN SFA 18 AND STATUS RELATIVE TO CONSERVATION REQUIREMENTS 5

SFA 18A 5

River Philip 5

East River (Pictou) 5

Sutherlands River 5

West River, Antigonish 6

SFA 18B 6

Margaree River 6

Estimates of salmon returns to Margaree River 7

Estimates of salmon returns to SFA 18 7

Estimates of spawners in Margaree River 7

Estimates of spawners in SFA 18 8

JUVENILE ATLANTIC SALMON ABUNDANCE 8

SFA 18A 8

Margaree River (SFA 18B) 8

Juvenile salmon densities and growth in the Margaree River 9

SMOLT MONITORING IN SFA 18 9

Margaree River 9

River Philip 10

JUVENILE ATLANTIC SALMON OF HATCHERY-ORIGIN 10

Activities of the Margaree fish culture station in 2011 10
Smolts with clipped adipose fin caught during the smolts sampling 10
Proportion of adult salmon with clipped adipose fin in the logbooks 11
ABUNDANCE INDICATORS 11
FISHERIES IMPACTS 12
Impacts of other fisheries on Atlantic salmon 12
Estimates of losses of salmon in fisheries (in rivers, estuaries, and high seas) 12
FISH PASSAGE ASSESSMENT 13
ADVICE RELATIVE TO A POTENTIAL KELT FISHERY IN RIVER PHILIP AND WEST RIVER (ANTIGONISH) 13
Biological characteristics of kelts captured by angling 14
Return rate of repeat-spawners to the Margaree River 14
Impacts of a potential kelt fishery 15
SOURCES OF UNCERTAINTIES 15
ACKNOWLEDGMENTS 16
REFERENCES 17

Correct citation for this publication:

Breau, C. 2013. Status of Atlantic salmon (*Salmo salar* L.) stocks in rivers of Nova Scotia flowing into the Gulf of St. Lawrence (SFA 18). DFO Can. Sci. Advis. Sec. Res. Doc. 2012/147. v + 54 p.

ABSTRACT

This document provides an assessment of the Atlantic salmon (*Salmo salar* L.) stocks of Salmon Fishing Area 18 of Gulf Nova Scotia. The information includes estimates of fisheries catches and harvests of salmon, estimates of returns and spawning escapements, indices of juvenile abundance, and an analysis of impacts of various fisheries on the Atlantic salmon stocks. The annual trends in abundance of Atlantic salmon populations in SFA 18 are assessed in relation to past years and to conservation requirements. Returns of Atlantic salmon to SFA 18 in 2011 were among the highest of the past two decades. In 2011 the estimated return of large salmon to the Margaree River was 5,200 fish with 95% probability that 4,300 fish returned, the highest value for the assessment series beginning in 1987. The estimated return of small salmon to the Margaree River in 2011 was 1,120 with 95% probability that 850 small salmon returned. After accounting for removals, conservation requirements for the Margaree River, the largest river of SFA 18, have been met every year since 1987. There were no adult salmon counts in rivers of mainland Nova Scotia (SFA 18A). Catch per unit effort from the recreational fishery is used as an index of adult returns. Catches of large salmon and small salmon per rod day increased in River Philip and West River (Ant.) during 2011 compared to the previous 5-year average whereas catches of large salmon and small salmon per rod day on East River (Pictou) were similar to the previous 5-year average. Potential hook and release spring recreational fisheries on kelts in River Philip and West River (Ant.) are expected to have minimal impact to conservation of these stocks.

RÉSUMÉ

L'évaluation de l'état des populations de saumon atlantique (*Salmo salar* L.) de la zone de pêche à saumon 18 (ZPS 18) pour la région de Golfe Nouvelle-Ecosse est présentée. Les informations comprennent des estimations de captures et de prélèvements de saumon dans les pêcheries, des estimations de montaisons et de reproducteurs, des indices d'abondance des juvéniles, et une évaluation des impacts de diverses pêcheries sur les populations de saumon atlantique. Les tendances temporelles de l'abondance des populations de saumon atlantique pour la ZPS 18 sont évaluées par rapport aux besoins de conservation. Les montaisons de saumon atlantique dans la ZPS 18 en 2011 étaient parmi les plus élevés des deux dernières décennies. Pour la rivière Margaree, la plus grande rivière de la ZPS 18, les retours de grands saumons en 2011 s'élevaient à 5 200 individus avec 95% de chance que la montaison était d'au moins 4 300 poissons, le plus haut niveau de la série d'évaluation datant de 1987. La montaison de petits saumons en 2011 pour la rivière Margaree était de 1120 poissons avec 95% de chance que la montaison était au moins 850 petits saumons. Après avoir tenu compte des pertes de saumon dans les pêches, les besoins de conservation pour la rivière Margaree ont été dépassés chaque année depuis 1987. Aucun décompte de saumons adultes est disponible pour les rivières de la partie continentale de la Nouvelle-Ecosse (ZPS 18A). Les taux de captures par unité d'effort dans la pêche récréative servent d'indices d'abondance des montaisons de saumons adultes. Les taux de captures en 2011 des grands saumons et des petits saumons dans les rivières Philip et West (Ant.) étaient supérieurs aux moyennes des cinq dernières années tandis que pour la rivière East (Pictou), le taux de capture était similaire à la moyenne. Les conséquences à la conservation d'une pêche récréative de remise à l'eau aux saumons noirs au printemps dans les rivières Philip et West (Ant.) sont jugées minimes.

INTRODUCTION

In 1984, commercial fisheries for Atlantic salmon (*Salmo salar* L.) in the Maritime provinces were closed and restrictions including mandatory hook and release measures for large salmon in the recreational fishery were introduced (DFO 1984). Spawning escapement increased initially in a number of rivers however the higher returns of salmon were not sustained. More restrictive management measures were put in place during the 1990s including the closure of the insular Newfoundland commercial salmon fishery and the Labrador fishery and the last commercial fishery in eastern Canada was closed in 2000. Currently, two user groups in the Gulf Region of Fisheries and Oceans Canada (DFO) have access to Atlantic salmon: Aboriginal peoples and recreational anglers. Aboriginal peoples have first access, after conservation requirements are met, based on communal needs for food, social, and ceremonial purposes (FSC allocations).

Atlantic salmon in the Maritime Provinces of eastern Canada are managed with area-specific harvesting regulations in nine management areas known as Salmon Fishing Areas (SFA 15 to 23; Fig. 1). Rivers in Nova Scotia that flow into the Gulf of St. Lawrence are part of the Salmon Fishing Area 18 (SFA 18) and managed by DFO Gulf Region.

Atlantic salmon are known to be present in 55 rivers of SFA 18; 29 of these rivers are located from the New Brunswick/Nova Scotia border to the Canso causeway (SFA 18A; Fig. 2) and the remaining 26 rivers are located in Western Cape Breton (SFA 18B). The Margaree River is the largest river in SFA 18 with a drainage area of 1,100 km^2.

Adult salmon return to rivers during May to November and spawning occurs from October to December. Spawning adults consist of small salmon (fork length < 63cm) and large salmon (fork length >= 63cm) with varying proportions of small and large salmon in the returns depending on the geographic area and river (Chaput et al. 2006b). Small salmon, also known as grilse or one-sea-winter (1SW), are mostly maiden fish (first time spawners) that have spent one year at sea. The large salmon consists of maiden fish that return to rivers as two-sea-winter (2SW) or older (e.g. 3SW) and repeat spawners (fish that have spawned previously); collectively large salmon are often referred to as multi-sea-winter salmon (MSW).

The Margaree River has the largest Atlantic salmon population in SFA 18. The Atlantic salmon population in the Margaree River and other rivers in SFA 18 return mostly as large salmon and consist mainly of 2SW maiden fish (LeBlanc et al. 2005). Atlantic salmon from rivers in SFA 18 undertake long oceanic migrations as shown by recoveries of tagged salmon at West Greenland and in Newfoundland and Labrador. Tagged smolts from the Margaree River in SFA 18 were recaptured at West Greenland during their second summer at sea and tagged bright salmon from the Margaree River have been recaptured along the Strait of Belle Isle, the northeast coast of Newfoundland and West Greenland in the year after spawning (Chaput et al. 1993).

Formal stock assessments of Atlantic salmon in rivers of SFA 18 have been conducted in the Margaree River since 1985 (Claytor and Chadwick 1985; Claytor and Leger 1986; Claytor et al. 1987; Claytor and Chaput 1988; Claytor and Jones 1990; Chaput and Jones 1991a; Locke et al. 1993; Chaput et al. 1992, 1994; Marshall et al. 1996, 1997, 1999, 2000; Chaput et al. 2006a; Breau et al. 2009). Formal assessments of stock status for Atlantic salmon in selected rivers of mainland Gulf Nova Scotia have been conducted since 1991 (Chaput and Jones 1991b; Locke et al. 1993; Chaput and Jones 1994; Claytor et al. 1995; O'Neil et al. 1996, 1997, 2000; Chaput et al. 2006a; Breau et al. 2009). An assessment of the Atlantic salmon stock status in the

Cheticamp River for 2004 was completed (Landry et al. 2005). Since the late 1990s, there has been no annual adult monitoring program in rivers of SFA 18. In 2010, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) identified the rivers in the southern Gulf of St. Lawrence including rivers of Gulf Nova Scotia, and the Gaspé Peninsula, as a Designatable Unit (DU) and this DU was assessed as "Special Concern" (COSEWIC 2010).

This document provides estimates of adult returns and spawning escapement of Atlantic salmon to rivers of SFA 18 and assesses salmon returns and spawners in relation to past years and conservation requirements. Catches and harvest levels of adult salmon, juvenile abundances, and impacts of other fisheries on the Atlantic salmon stocks are presented. The impacts of a potential hook and release recreational fishery for kelts in River Philip and West River (Antigonish) are evaluated.

ATLANTIC SALMON FISHERIES

Aboriginal food, social and ceremonial (FSC) fisheries and recreational fisheries occur in several rivers of SFA 18. The details of the fisheries are included in the Integrated Fisheries Management Plan (IFMP) 2008 to 2012 (DFO 2008).

FIRST NATIONS FISHERIES

In Cape Breton, five First Nations (Chapel Island, Eskasoni, Membertou, Wagmatcook and Waycobah) have FSC allocations to harvest salmon from the Margaree River; 145 small salmon and 345 large salmon (Table 1). The salmon can be harvested using angling, spearing and snaring and in the estuary using trapnets. The Millbrook First Nation has an FSC allocation to harvest 10 small or large salmon in the Margaree River (Table 1). Pictou Landing First Nation has an allocation of 5 small salmon and 10 large salmon in the Margaree River (Table 1). Eskasoni and Waycobah are permitted to fish for kelt in the Margaree River.

In rivers of mainland Nova Scotia, three First Nations (Indian Brook, Millbrook and Pictou Landing) have FCS allocations of Atlantic salmon with a combined allocation of 195 small, 257 large salmon and 40 small or large salmon (Table 1). The FSC fisheries are permitted in the entire watersheds of River Philip, Pugwash, Wallace, Waugh, French, West (Pictou), West (Ant.), Shinimicas rivers and River John. FSC gillnet fisheries with allocations of 10 small and 30 large salmon are permitted in the Merigomish Harbour, Pictou County area. The FSC harvest dates for bright salmon vary by river but in general, are scheduled for the summer and fall season. The communities have scheduled dates to harvest kelts in the spring in River Philip, Wallace and Waugh rivers.

The Native Council of Nova Scotia (off-reserve aboriginal peoples) had allocations to fish Atlantic salmon in rivers of SFA 18 in 2011 totalling 1,820 salmon (small and large salmon combined) that could be taken from a large number of rivers in Nova Scotia. The fishing season was from January 1 to May 14th for male small salmon and large salmon, May 15th to 31st for male and female small salmon and June 1st to November 5th for small salmon only (DFO 2008).

First nations harvests

In 2011, the reported FSC harvest from SFA 18 was 58 large salmon. The harvest information from these fisheries is incomplete.

RECREATIONAL FISHERY

The recreational fishery in rivers of SFA 18 is regulated by season, gear, daily and seasonal bag limits. There is a retention fishery for small salmon and a mandatory catch and release for large salmon. Between 2008 and 2011, the season and daily bag limits in all rivers of SFA 18 were 4 and 2 small salmon, respectively, which was down from 8 and 2 small salmon prior to 2008 (DFO 2008). Only barbless or pinched barb artificial flies are permitted from October 1 to October 31. Barbed artificial flies are permitted prior to October 1. Four tags are received with the purchase of every license. Small salmon that are retained must be tagged by inserting the tag through the mouth and gill cavity. It is mandatory that the stub return on the salmon license be properly filled out and mailed within seven days of the close of the season or fishing privileges may be suspended. License stubs should be returned even if the person did not fish or if no fish were caught or retained. The catch and effort information recorded on the license stubs are used to determine exploitation rates to give science advice for the proper management of Atlantic salmon stocks.

The angling season in rivers of SFA18 extends from September 1 to October 31 in most rivers of SFA 18. The exceptions are the Margaree River and the Cheticamp River. The angling season in Margaree River is from June 1st until October 15th except for upstream from the highway bridges at East Margaree to the Big Intervale bridge on the Northeast Margaree River and upstream to the Scotsville highway bridge on the Southwest Margaree River which is from June 1st to October 31st. The Northeast Margaree River and tributaries upstream from the Big Intervale bridge are closed all year.

The angling fishery in the Cheticamp River is managed by Parks Canada and the season extends from May 19th to September 30th for the section upstream from the lower end of the Terre Rouge Pool and the season extends from May 19th to October 31st for the lower end of Terre Rouge Pool up to and including the Fence Pool. There is no retention of any salmon allowed in the Cheticamp River.

Angling statistics from license stubs

The sale of recreational Atlantic salmon fishing licences is managed by the province of Nova Scotia. Licence sales from 1987 to 1990 varied between 7,191 and 8,615 licences annually (Fig. 3). Since 1998, annual sales have ranged from 1,938 to 2,600 licences (Fig. 3). In 2011, 2,491 Atlantic salmon licenses were purchased in Nova Scotia (1,932 full season licences and 559 7-day licences); each licence had four tags allocated for small salmon retention. To date (February 2012), 642 licence stubs were returned by anglers, a 26% response rate. The licence stub information is compiled in a recreational catch database. The observed data (not corrected for total licence sales) was used to estimate adult salmon returns to the Margaree River, and to SFA 18 overall. Total catch and total effort had to be estimated for the total licence sale because not all licence stubs were returned. In the software used, the catch and effort data from voluntary returns were used to build a regression analysis that estimated catch and effort for non-returned licence stubs.

Angling statistics for 2011 are preliminary because licence stubs will likely be received until September 2012. Anglers reported catch and effort from 16 rivers in 2011. The angling effort in SFA 18A and 18B in 2011 was estimated to be 5,959 and 10,098 rod-days, respectively, the highest estimated angling effort since 1984 (Table 2). Although the data are preliminary for 2011, the estimated catch of small and large salmon was well above the previous 5-year average in SFA 18A and 18B. The large salmon caught and released in 2011 were estimated to

be 2,547 and 2,924 fish in SFA 18A and 18B, respectively (Table 2). It was estimated that 991 small salmon were caught in SFA 18A during 2011 of which 213 fish were retained. The small salmon catch in SFA 18B was estimated at 707 fish of which 250 were retained. All persons purchasing a salmon licence received 4 tags to retain small salmon. In 2011, 2,491 licences were sold in Nova Scotia for a total of 9,964 tags available for the potential retention of small salmon (2,491 licenses in 2011 x 4 small salmon). It was estimated that a total of 463 small salmon were harvested in SFA 18 in the 2011 recreational fishery.

The angling data obtained from the licence stubs are presented by river in Appendices 1 to 6. The total salmon caught and the catch per unit of effort (rod days) in three rivers of SFA 18A (West R. (Ant.), East R. (Pictou) and R. Philip) were much higher in 2011 than in 2010 (Fig. 4) and were well above the previous 5-year averages (2006-2010; Appendices 2, 3, 6). The catch of large salmon in the Margaree River for 2011 was estimated to be double the catch that occurred in 2010 and well above the previous 5-year average (Fig. 5; Appendix 1). The total catch per unit of effort of salmon (size groups combined) in 2011 was the highest of the time series largely because of the increased return of large salmon (Fig. 5).

CONSERVATION REQUIREMENTS

The conservation requirement for Atlantic salmon in all rivers of the Gulf Region was defined as an egg deposition rate of 2.4 eggs per m^2 of juvenile rearing habitat (CAFSAC 1991a) (Table 3). The objective was to obtain the egg requirements from large salmon (CAFSAC 1991b) because the majority of salmon returning to rivers of SFA 18 consisted of large salmon and these were, on average, 75% female (Marshall 1982). CAFSAC (1991b) also provided an objective for small salmon for ensuring a 1:1 male to female ratio at spawning time, corresponding to the conservation requirements for large salmon. This objective has in the past been used to manage access for fisheries on small salmon in cases where the large salmon returns were below conservation requirement; however a firm biological basis for this objective has yet to be documented.

The conservation requirements of large salmon for the Margaree River were calculated as follows. The egg deposition rate was multiplied by the estimated fluvial habitat area which was used for juvenile production. As an example, the total habitat area in the Margaree River has been estimated to be 2.798 million m^2 (Marshall 1982) and the total egg requirements are 6.714 million eggs. At an assumed fecundity of 6,483 eggs per large salmon (Chaput et al. 1992), the 6.714 million eggs would be obtained from 1,036 large salmon. Based on average historical biological characteristics of large salmon in Margaree River (Marshall 1982), the required 1,036 large salmon are comprised of 777 females (0.75 * 1,036) and 259 males (0.25 * 1,036). The biological characteristics were summarized from large salmon sampled at a trap and creel surveys in the Margaree River between 1973 and 1977 (Marshall 1982). More contemporary sampling indicated that the inter-annual variation in the proportion of females in large salmon ranges from 0.62 to 0.79 (LeBlanc et al. 2005). The deficit males (518 fish) in the large salmon component required to meet the 1:1 male to female objective come from the small salmon. At a male proportion of 0.89 in the small salmon (Marshall 1982), the 518 deficit males are equivalent to 582 small salmon. Biological characteristics collected from estuary trapnets installed in the Margaree River during 1987 to 1996 showed that the annual proportion of females in small salmon varied from 4% to 43% (average of 16%) (LeBlanc et al. 2005).

ADULT RETURNS TO RIVERS IN SFA 18 AND STATUS RELATIVE TO CONSERVATION REQUIREMENTS

SFA 18A

In SFA 18A, a total of 2,257 large salmon are needed to meet conservation requirements in the 17 rivers for which egg requirements have been calculated (Table 3). River Philip and West River (Antigonish) have the highest conservation requirements with 358 and 353 large salmon, respectively (Table 3). Conservation requirements in other rivers of SFA 18A are less than 300 large salmon per river.

River Philip

The egg requirement for River Philip is estimated to be approximately 2.31 million eggs which would be obtained from 358 large salmon. CAFSAC (1991b) also defined a secondary objective of a 1:1 male to female ratio which would correspond to 75 small salmon in River Philip. Adult returns to River Philip were estimated using a mark-and-recapture experiment in 1996 and 1999. Fish were captured by seining and individually marked using streamer tags. Days following fish marking, divers counted marked and unmarked fish. In 1996, the post-fishery salmon return estimate (spawning escapement) was 1,084 (5^{th} and 95^{th} percentile: 563 to 2,391) large and small salmon combined (O'Neil et al. 1997). In 1999, the post-fishery escapement was estimated to be 506 large salmon (O'Neil et al. 2000). Conservation requirement was met during years when returns estimates were generated from mark-and-recapture data. Since 1999, no fish count was done in River Philip to generate a formal adult salmon population estimate. Catch per unit effort from the recreational fishery was used as an index of adult abundance but there are no population estimates to determine if conservation requirement was met.

Angling catch of large and small salmon per rod day increased in River Philip during 2011 compared to the 5-year average (2006-2010) (Fig. 4).

East River (Pictou)

The egg requirement for East River (Pictou) was estimated to be approximately 1.75 million eggs which would be obtained from 271 large salmon. Based on a 1:1 male to female ratio, 57 small salmon are needed to meet the secondary objective in this river. The last population estimate was generated from a mark-and-recapture experiment in 1996 (O'Neil et al. 1997). Conservation requirement was met with an estimated mean spawning escapement of 529 large salmon. Since 1996, no population assessment has been conducted on East River (Pictou). Catch per unit effort from the recreational fishery was used as an index of adult abundance but there are no population estimates to determine if conservation requirement has been met.

Catch of large and small salmon per rod day on East River (Pictou) in 2011 was within the 5-year average (2006-2010) (Fig. 4).

Sutherlands River

Three rivers discharge into Merigomish Harbour in Pictou County: Sutherlands, French (Pictou) and Barney's River. These small rivers have conservation requirements (egg requirement from large salmon) of 25, 65, and 79 large salmon, respectively. The salmon stocks are small in these rivers which makes them more vulnerable to over-exploitation. There is a First Nation

FSC allocation and harvest in the Merigomish Harbour which is practiced using gillnets. In the past, Sutherlands River was used as an index river to determine attainment of conservation requirements in the three rivers. The underlying assumption was that if Sutherlands River met conservation requirements, French and Barney's rivers did as well. There is an impassable natural barrier 5.6 km above the head of tide in Sutherlands River. Previously, snorkel surveys were conducted in this lower accessible stretch of river. The number of small salmon, large salmon and other species were recorded. Snorkel counts were conducted in 1995 to 1999 with conservation requirements being met from 1996 to 1999 (O'Neil et al. 2000). In 1995, 24 large salmon were counted with 25 large salmon required to meet conservation requirements.

In November 2010, a snorkel count was done in Sutherlands River. A total of 21 large and 18 small salmon were counted in Sutherlands.

West River, Antigonish

The egg requirement for West River (Ant.) was estimated to be approximately 1.15 million eggs which would be obtained from 353 large salmon. Based on the secondary objective of a 1:1 male to female ratio, 1 small salmon would be needed. In 1995, a population estimate was computed for West River using the exploitation rate for the Margaree River and angling catches from license stubs for the West River (O'Neil et al. 1996). Based on the estimated returns generated, conservation was not met in 1995. No fish count was ever done on West River to estimate salmon returns to the river. Since then, catch per unit effort from the recreational fishery was used as an index of adult returns but there are no population estimates to determine if conservation requirement was met.

Angling catch of large and small salmon per rod day increased in West River (Ant.) during 2011 compared to the 5-year average (2006-2010) (Fig. 4).

SFA 18B

Margaree River

The egg requirement for Margaree River was estimated to be approximately 6.71 million eggs which would be obtained from 1,036 large salmon. The estimates of salmon returns to the Margaree River were derived from a Bayesian model that incorporates data from mark and recapture experiments (1988 to 1996), catch and effort from license stubs (1987 to 2011) and catch and effort from voluntary anglers logbooks (1987 to 2011) (Breau and Chaput 2012). During 1988 to 1996, returns of Atlantic salmon to the Margaree River were estimated using mark and recapture techniques. For 1987 to 2011, angling catch and effort data from voluntary angler logbooks and provincial license stubs were used in conjunction with the mark and recapture data to derive a catchability coefficient for the recreational fisheries (Breau and Chaput 2012). The catchability coefficient per rod day was estimated from angling catch and effort data for the years 1988 to 1996 when a mark and recapture program was used to estimate returns, independently from angling catch (Breau and Chaput 2012). Since 1997, angling catch and effort data was used to estimate returns of salmon to Margaree River since no adult salmon were counted or marked to estimate returns to the river. The catchability coefficient generated during 1988 to 1996 was applied to the other years assuming it to be the same for those years.

Estimates of salmon returns to Margaree River

The median of the posterior distribution of the estimated returns of large salmon to the Margaree River in 2011 was 5,200 large salmon with 95% probability that at least 4,300 fish returned (Fig. 6). The estimated return of large salmon for 2011 was the highest since 1987 (Fig. 6; Appendix 7). The median of the posterior distribution of the estimated returns of small salmon to the Margaree River in 2011 was 1,120 salmon with 95% probability that at least 850 small salmon returned in 2011 (Fig. 6). The small salmon return for 2011 was within the range of return estimates for 1987 to 2010.

Estimates of salmon returns to SFA 18

Estimates of salmon returns to SFA 18 were derived from estimates for the Margaree River. The estimates of returns to Margaree River were adjusted by the ratio of angling catch in the SFA relative to the Margaree catch (Breau et al. 2009).

A median estimate of 9,600 large salmon returned to SFA 18 in 2011; the highest median estimate of the time series (5^{th} to 95^{th} percentile range: 4,700 to 14,600) and near the 1996 and 1997 estimates (Fig. 7). The median estimate of small salmon returns in 2011 was 2,500 with a 95% probability that at least 990 small salmon returned (5^{th} to 95^{th} percentile range: 990 to 4,000) (Fig. 7).

Estimates of spawners in Margaree River

Spawners are the salmon that remain in the river to spawn after fisheries removals (harvest, catch and release mortality). Fisheries removals are subtracted from the yearly estimated returns to estimate spawning escapements.

In the calculations of conservation requirement for the Margaree River, the eggs required to meet conservation requirements are calculated based on large salmon only because the majority of the returns consist of large salmon. However, females composed, on average, 16% (range: 7% to 43%) of the small salmon returns during 1987 to 1996 (LeBlanc et al. 2005). Even though there are fewer eggs per female small salmon, the genetic composition of these fish may play a role in the maintenance of the small salmon component of the returns.

In the Margaree River, removals for 1987 to 2011 consisted of the retained angling catch for small salmon and a hook and release mortality estimate of 5% for small salmon and large salmon angled and released. Catch rates used to estimate adult returns to the Margaree River varied between 0.29 and 0.71 for small salmon and between 0.29 and 0.66 for large salmon for the 2001 to 2011 time series. The removals from the aboriginal fisheries were incomplete and not included in the calculations of spawner escapements. However, it is important to acknowledge that large and small salmon are harvested from the aboriginal fisheries.

The preliminary estimate of spawning escapement for large salmon in the Margaree River in 2011 was 5,180 (5^{th} to 95^{th} percentile range: 4,200 to 6,150) (Fig. 6) indicating that the conservation requirement of 1,036 large salmon was met. The returns and spawning escapements of large salmon in the Margaree River have exceeded the conservation requirement every year since 1987 (Figs. 6, 8). The estimate of the small salmon spawning escapement in 2011 was 910 (5^{th} and 95^{th} percentile: 590 to 1,220) indicating that the median estimate exceeded the secondary objective of 518 small salmon (Fig. 6).

Estimates of spawners in SFA 18

The estimate of spawners in SFA 18 was derived from estimates of spawners to the Margaree River, adjusted for the ratio of the SFA 18 angling catch to the Margaree River catch.

The preliminary estimate of spawning escapement for large salmon in SFA 18 in 2011 was 9,400 (5^{th} to 95^{th} percentile range: 4,540 to 14,280) (Fig. 9). As with the Margaree River, the 2011 estimate of large salmon spawners in SFA 18 was the highest of the time series (Fig. 9). The preliminary estimate of spawning escapement for small salmon in SFA 18 in 2011 was 2,000 (5^{th} to 95^{th} percentile range: 590 to 1220), an estimate that was within the range observed in the time series (Fig. 9).

JUVENILE ATLANTIC SALMON ABUNDANCE

Relative abundance of wild juvenile salmon in freshwater was determined by electrofishing surveys. Juvenile surveys have been conducted in the Margaree River since 1957 (Chaput and Claytor 1989; LeBlanc and Chaput 2003) and since 1987 in a number of rivers of SFA 18A (mostly West River (Ant.), East River (Pictou) and River Philip) (see Breau et al. 2009). Prior to 1993, sites were closed with barrier nets, the total depletion method was used and abundance estimates were generated by the algorithm developed by Zippin (1956).

In 1993, catch per unit effort (CPUE) was introduced to increase the spatial coverage of sampling (Chaput et al. 2005). Sites in SFA 18 have been surveyed using the catch per unit effort method since then. In 2001 and 2002, sites in the Margaree River were electrofished using the depletion method to calibrate the CPUE sites. The CPUE data collected each year was converted to fish density using the regression line obtained from the total removal method (see Chaput et al. 2005 for description of method).

Herein, fry refers to young-of-the-year (or 0+) Atlantic salmon and parr refers to all juvenile salmon of age-1 and older. Juvenile salmon having a clipped adipose fin were identified as fish of hatchery-origin.

SFA 18A

In September 2011, the following sites were electrofished in SFA 18A: three sites in West River (Antigonish), two sites in Barney's River, three sites in East River (Pictou), two sites in Wallace River and two sites in River Philip.

Typically, fry density exceeded 40 fish per 100 m^2 (Wallace River was at 38 fish per 100 m^2) (Figs. 10 to 12); lower densities than in the 1990s. However, parr densities were comparable to earlier estimates with more than 20 parr per 100 m^2 (15 and 16 parr per 100 m^2 in East River, Pictou and Wallace River, respectively). The higher fry abundance in the 1990s did not result in higher parr abundance which suggests that fry survival was less than in recent years. Large yearly variations in fry densities likely resulted from the low number of sampling sites, specifically within rivers on mainland, and changes in physical characteristics of some sites.

MARGAREE RIVER (SFA 18B)

In September 2011, 11 sites were electrofished in the Margaree River. Water conditions for electrofishing were good and the crew felt that few (if any) shocked fish escaped capture.

Fry were present at only four of the 11 sites surveyed in 2011; sites with fry present were tributaries or the headwaters. No fry were found in sites of the main stem (Fig. 13). Fry densities in the Margaree River during 2011 were 7-fold lower than the average of 1985 to 2010 (important management changes were made to the commercial and recreational fisheries beginning in 1984) (Fig. 14) and relative to fry densities in other rivers of Gulf Nova Scotia. A flood of over 100-years occurred in the Margaree River during December 2010 (Daniel Caissie, pers. comm.) leading to important changes in the streambed and river morphology. Movement of the riverbed likely buried the incubating eggs in redds. Therefore, the absence of fry at many sites is attributed to losses from the flood event rather than an absence of spawning in the Margaree River.

There was also a major flood in March 2003 that resulted in low fry abundance during the 2003 juvenile survey (Gérald Chaput, pers. comm.). The fry density in 2003 was low (Fig. 14) and the smolt production for that year class (year class 2002) was estimated to be 73,576 smolts (Table 4). The majority of fish in the year class of 2002 migrated to sea as 2+ smolts in 2005 and 3+ smolts in 2006 (Table 5). The smolt estimate in 2005 that included 2+ smolts from the 2002 year class was 103,624 fish which is within the range of estimates for the 1999 to 2005 year classes (Table 5). Fish from several year classes contribute to the smolt abundance in a given year which provides buffer for small year classes. However, one important difference between the year class of 2002 and 2010 is that fry were present at the five sites surveyed in 2003 which was not the case in the 2011 survey.

The adult salmon returns estimate was high in 2011 which suggest that fry densities should be high in 2012.

Parr densities in 2011 were slightly higher than in 2009 and 2010, but densities for years 2009 to 2011 were half the densities observed in the 1985 to 2010 long-term average (Fig. 14).

Juvenile salmon densities and growth in the Margaree River

The average fry and parr densities at six sites in the Margaree River from 1991 to 2011 were used to determine relationships between juvenile salmon densities and growth. Parr included small and large parr because no distinction was made for most years.

Parr density in year (t+1) was positively correlated to fry density in year (t) (Fig. 15). The average fork length decreased with increased fry density (Fig. 16). Growth was presumably better at low fish densities because of greater food availability and less competition for food and space. In 2011, the juvenile densities were low but the average fork lengths of fry, 1 year old and 2 year old parr were larger than past years which indicated that growth was better (Fig. 17).

SMOLT MONITORING IN SFA 18

MARGAREE RIVER

Following changes in the management of Atlantic salmon beginning in 1984 (DFO 1984), juvenile salmon densities increased in monitored rivers of the southern Gulf of St. Lawrence compared to densities in the 1970s. Unexpectedly, the higher juvenile densities in the Margaree River did not translate to greater returns of adult salmon to the river. The lack of observed returns could be explained by a lack of increase in smolt abundance or lower marine survival in the past 20 years despite higher smolt abundances, or a combination of both. The monitoring of smolt in the Margaree River quantified the abundance and biological characteristics of smolts to

infer whether there was a bottleneck in the freshwater which was limiting the abundance of smolts going to sea.

Smolt migration was monitored in Margaree River during 2001 to 2009 (Clément et al. 2007; Breau et al. 2010). A rotary screw trap was installed to characterize smolt migrations, estimate abundances, collect biological data and quantify relative inter-stage survival rates.

Typically, the smolt migration in the Margaree River began early May, peaked in late May to early June and finished by mid-June. The estimates of wild smolt abundance during 2002 to 2009 varied from a low of 83,100 fish (5^{th} to 95^{th} percentile range: 69,100 and 97,000) in 2003 to a high of 128,400 fish (5^{th} to 95^{th} percentile range: 101,249 and 156,431) in 2008 (Breau et al. 2010). Smolts were predominantly of age 2 and age 3 (with a small proportion of age 4 and age 5). Females comprised 70 to 77% of the smolt run in any given year.

The relative survival rates of parr to smolt varied between 3% and 7% (Table 4). On average, 2.3 to 4.6 smolts per 100 m^2 were produced in the Margaree River. The relative return rate ranged between 0.2% and 1.6% from smolt to small salmon and between 1.9% and 6.2% from smolt to large salmon (Table 4).

In addition to Atlantic salmon, 15 other fish species were captured in the rotary screw trap over the years (Breau et al. 2010). Brown trout, a non-native species, was also sampled.

RIVER PHILIP

In 2011, a smolt monitoring program was initiated in River Philip (Breau and Ripley 2012). The objective was to quantify and compare the population abundance and biological characteristics of smolts in River Philip to other rivers. A total of 14 fish species were captured using a rotary screw trap with 95% of the total catch consisting of rainbow smelt. The estimated smolt run was 24,300 with a 95% probability that at least 13,000 smolts migrated downstream. The smolt estimate per unit area corresponded to 2.5 smolt per 100 m^2; an estimate that was comparable to larger river systems such as the Margaree, Miramichi and Restigouche rivers.

JUVENILE ATLANTIC SALMON OF HATCHERY-ORIGIN

ACTIVITIES OF THE MARGAREE FISH CULTURE STATION IN 2011

Some of the juvenile salmon and smolts released from the Margaree fish culture station can be recognized by a clipped adipose fin. Unclipped salmon of hatchery-origin were released in the Margaree River during 2009 and 2010 which makes the distinction of wild and hatchery-reared salmon not possible. In 2011 as in previous years, salmon of hatchery-origin were released in the Margaree River (SFA 18B) and the Waugh river (SFA 18A). A total of 110,228 juvenile salmon (108,530 fish of 20-26 week after absorption of yolk sac, 1,698 fish of 26-52 week after absorption of yolk sac) were released in the Margaree River during June, November and December 2011. The number of smolts released in the Margaree River during May and June 2011 was estimated at 32,398. A total of 9,700 fry and 3,000 parr were released in the Waugh River during 2011. Not all these stocked fish were externally marked to permit identification.

Smolts with clipped adipose fin caught during the smolt sampling

During the smolt monitoring activities of springs 2003 to 2009, juvenile salmon released from the fish culture station the previous fall and 1-year old smolts released in the spring of the year

were captured in the rotary screw trap (Clément et al. 2007, Breau et al. 2010). Most salmon with a clipped adipose-fin were 1-year old smolt. More than 2,000 1-year old hatchery origin smolts were captured annually at the monitoring facility except in 2008 when smolts were released after the smolts sampling was completed.

Proportion of adult salmon with clipped adipose fin in the logbooks

Since 1987, a group of anglers have volunteered to participate in a logbook program by recording all of their fishing activities in Nova Scotia. The total number of participants has decreased from 70 anglers in 2000 to 39 anglers in 2011. One of the observations recorded by anglers was whether the small and large salmon captured had a clipped adipose fin. The data were summarized to show the number and percentage of small and large salmon angled in the Margaree River that were of wild and hatchery-origin over the years 2000 to 2011.

During 2000 and 2011, the number of small salmon (wild and adipose-fin clipped) caught by anglers participating in the logbook program varied from 3 small salmon in 2009 to 42 small salmon in 2002 and 2011 (Table 6). The number of large salmon (wild and adipose-fin clipped) caught by anglers varied between 30 large salmon caught in 2007 to 115 fish in 2011 (Table 6). In any given year, anglers always caught a greater number of large salmon than small salmon. In 2004, 2007 and 2009, no small salmon with a clipped adipose fin were reported caught by anglers (Table 6) and in 2001, 2003 and 2006, 10%, 15% and 16% of the small salmon caught had a clipped adipose fin. There were no large salmon with a clipped adipose fin reported angled in 2000, 2007 and 2010. In all, the percentage of large salmon caught with a clipped adipose fin varied between 0 to 3% except in 2003 when 35% of large salmon caught were reported as clipped. Hence, the majority of salmon caught by these anglers were wild fish. These data indicate that the majority of the returns of salmon to rivers in Gulf Nova Scotia including the Margaree River are from natural spawning. It is imperative that any fish which are stocked from the hatchery be marked for identification before release.

ABUNDANCE INDICATORS

As of 2012, the formal assessments of stock status for Atlantic salmon will be conducted on a multi-year cycle. One question raised in the terms of references was how science will provide information on stock status in non-assessment years.

Adult returns and adult return rates were found to be the most informative indicators of Atlantic salmon stock abundance (ICES 2007). Small salmon abundance in the Margaree River is used as an indicator of abundance in the ICES framework of indicators used for the assessment of the validity of multi-year advice for the West Greenland fishery (ICES 2011).

During years with no formal assessment of salmon stock status, the estimate of adult returns to the Margaree River is used by DFO Science Branch to infer abundance in all rivers of SFA 18. The catch and effort in the recreational fishery is also used as indices of abundance. The angling statistics in rivers of SFA 18A follow the same trends as in the Margaree River. As currently done, adult returns to the Margaree River and angling statistics could still inform on adult salmon abundance in rivers of SFA 18.

The DFO Science Branch has been conducting juvenile surveys in the fall of each year for a number of years. The abundance of young-of-the-year salmon in a river is a good indicator of the spatial extent and the level of spawning. However, juvenile abundance is not a good indicator of current adult abundance because surveys are done the year after the adult returned

to spawn. The young-of the-year abundance does not provide the information to determine if conservation requirements were met.

FISHERIES IMPACTS

IMPACTS OF OTHER FISHERIES ON ATLANTIC SALMON

There are active commercial licenses for gaspereau (alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis*), rainbow smelt and American eel in SFA 18. A survey reported the knowledge of DFO fishery officers on the level of salmon by-catch in the three above-mentioned commercial fisheries (Chiasson et al. 2002). In summary, based on their knowledge, the three fisheries had none to minimal by-catch of salmon in their fishing gear (Table 7). However, the officers felt that moderate by-catch of salmon was occurring in the Merigomish and Pugwash harbours. There were also reports of Atlantic salmon potentially destined for SFA 18 having been caught as by-catch in the mackerel driftnet fishery in 2011 (DFO 2012).

Estimates of losses of salmon in fisheries (in rivers, estuaries, and high seas)

In river losses occur in the recreational fishery for small salmon (retention and catch and release mortality), as catch and release mortality in the recreational fishery for large salmon, and in aboriginal fisheries for small and large salmon. Losses from disease likely also occur. Usually, 3% mortality is attributed to catch and release of Atlantic salmon (DFO 2012). Historically, bacterial kidney disease was present in salmon from the Margaree which likely increased the mortality of salmon so a 5% mortality rate has been applied to fish that have been caught and released (CAFSAC 1991b). In river losses of salmon from catch and release mortality in the recreational fishery in 2011 were estimated to be 62 small salmon and 89 large salmon. The total salmon allocations to aboriginal peoples in SFA 18 were 220 small and 482 large salmon therefore those fish could have potentially been removed from rivers in SFA 18. These allocations are not included as removals in the calculations of spawning escapement.

Estuarial losses consist of the aboriginal catches but the reports for this fishery are incomplete.

Repeat spawning salmon have been captured in the West Greenland fishery in a number of years (Chaput et al. 1993). Tagged smolts from the Margaree River smolt monitoring program have also been reported from the fishery at West Greenland, during the fish's second summer at sea. The fishery at West Greenland has reported catches of 9 to 43 t in the past ten years, with the second highest catches since 1997 reported for the 2010 fishery at 40 t (plus an estimated 10 t of unreported catch). The estimated catch of North American origin salmon at West Greenland has varied between 2,300 and 10,000 fish, with 93% to 98% of the catch being 1SW non-maturing salmon, i.e. fish destined to have been 2SW or 3SW maiden salmon, had they not been captured (ICES 2011). The monthly mortality rate of salmon from the time of the West Greenland fishery (Aug. to Dec.) to the return to homewaters (July of the following year) has been estimated to be 0.03 per month, equivalent to a survival rate of 0.74 over the 10 month period.

From the run reconstruction conducted by the ICES Working Group on North Atlantic Salmon (ICES 2011), we can estimate the number of SFA 18 origin 2SW salmon likely to have been harvested at West Greenland at the 1SW non-maturing stage using the following input data:

A) Total catch of salmon (in numbers) at West Greenland in year t.

B) Catch of North American fish = Proportion of the catch which is North American origin * A.

C) Fish captured at West Greenland must be discounted for the proportion that would have died before returning to Canada, by a factor (instantaneous) of 0.03 per month. The fishery at West Greenland runs from mid-August to November. So time between fishery at West Greenland and returns to Gulf would be (September fishery in 2009 to returns to Gulf in July 2010) 10 months so mortality (proportion) would = 0.259 (1-exp(-0.03*10)).

Using estimates of returns of 2SW salmon in North America in year t+1, an estimate of the proportion of the catches of North American fish by SFA in Gulf Region is obtained, assuming that the stocks from all regions of eastern North America are exploited at the same rate at West Greenland.

D) Using returns by SFA within Gulf region, an estimate of the catch at West Greenland of SFA 18 origin salmon is obtained: SFA18 returns 2SW / North America returns of 2SW X C.

Estimated catch of 2SW equivalents of SFA 18 origin salmon at West Greenland in the past ten years has varied from 233 to 490 fish annually (Table 8), representing 4% to 17% of the 2SW returns to SFA 18. A smaller proportion of the large salmon in this SFA are 3SW and repeat spawners (12%).

Most of the high sea's losses since 1998, since closure of the commercial fisheries in Canada, would occur at West Greenland although some of the losses may also occur in the Labrador FSC and resident food fisheries and in the fishery at St. Pierre & Miquelon. The landings of large salmon from the Labrador fishery have varied between 6 and 17 t during 2001 to 2010 with 2SW salmon catches estimated to be in the range of 700 to 2,000 fish per year, the majority expected to be of Labrador origin. The fishery at St. Pierre & Miquelon has captured between 2 and 3.6 tons in the past ten years, about three quarters were small salmon, the remainder large salmon with estimated 2SW catches of just over 200 to just under 400 fish annually (ICES 2011).

FISH PASSAGE ASSESSMENT

Habitat fragmentation and impediments to fish passage can greatly impact diadromous fish by preventing migration to spawning habitats and rearing habitats. A preliminary assessment of stream crossings in Gulf Nova Scotia (SFA 18) was conducted as part of the Habitat Protection program and this assessment identified the extent of habitat fragmentation and impediments to fish passage (François Plante, DFO, pers. comm.). Based on an inventory of stream crossings within the first kilometer inland above the head of tide in rivers of Gulf Nova Scotia, impediments to fish passage were noted at 47% of the 669 sites studied. Not all these small streams, especially the very small and coastal streams, would be used by salmon.

ADVICE RELATIVE TO A POTENTIAL KELT FISHERY IN RIVER PHILIP AND WEST RIVER (ANTIGONISH)

In 2010, the Cumberland County River Enhancement Association and the West River Association submitted a request for a hook and release kelt fishery on River Philip and West River (Antigonish). Fisheries and Aquaculture Management at Fisheries and Oceans requested science advice on the impacts to conservation of a potential hook and release recreational fishery on kelts in River Philip and West River (Antigonish).

Kelts are the small and large salmon that have spawned the previous fall and overwintered in the river prior to their migration to sea. In the spring, a proportion of kelts begins feeding and migrate to sea to feed and grow. The kelts can be angled during the time that they begin feeding. There are presently no recreational fisheries for kelts in Nova Scotia.

The recreational fishery for bright Atlantic salmon is conducted in the fall during (or prior) to migration of salmon to spawning areas. The fishery is practiced mainly on maiden fish (first time spawners). The recreational fishing season in those two rivers is from September 1st to October 31st. There is a retention fishery on small salmon with the daily and season bag limit of 4 and 2 small salmon, respectively.

In rivers of Nova Scotia flowing into the Northumberland trait (SFA 18A), adult salmon typically return to rivers in late fall (Claytor 1996). Historically, adult returns to River Philip also occurred throughout the summer (Chaput et al. 2006a). The spawner requirements in River Philip and West River (Ant.) are 358 and 353 large salmon, respectively. There are no counts of adult returns in rivers of SFA 18A and it is not known if conservation requirements are met however juvenile surveys over the last 10 years indicate juvenile abundance in River Philip and West River (Ant.) remains relatively constant (Figs. 10 and 12).

BIOLOGICAL CHARACTERISTICS OF KELTS CAPTURED BY ANGLING

The Cumberland County River Enhancement Association in collaboration with DFO Science collected scales samples from kelt caught by angling in May 2007, 2010 and 2011. No kelts were captured in 2009 because of high water and an early spring. The objective was to collect data on the proportion of repeat-spawners in River Philip.

A total of 76 kelts, 120 kelts, and 63 kelts were caught during May 2007, 2010 and 2011, respectively (Table 9). More than 95% of the kelts captured had migrated from the river as 2 year old smolts. Small salmon constituted 1% to 25% of the samples whereas 2SW composed 68 to 88% of the samples. The proportion of 3SW and older varied between 3% and 24% depending on the year.

All small salmon and 2SW salmon sampled were first time spawners. The proportion of repeat-spawners was 18% in 2007, 6% in 2010 and 3% in 2011.

RETURN RATE OF REPEAT-SPAWNERS TO THE MARGAREE RIVER

There are no estimates of adult salmon returns to calculate return rates to the river to River Philip and West River (Ant.) therefore return rate of repeat-spawners to Margaree River was calculated as a proxy. The proportion of repeat-spawners in fish sampled in River Philip was comparable to Margaree River with more than 90% of the returns consisting of first-time 2SW spawners (LeBlanc et al. 2005).

Biological characteristics were collected on salmon returning to the Margaree River when a trapnet was operating during 1987 to 1996 (LeBlanc et al. 2005). Return rates of small salmon and large salmon were included as an indicator of return rates for the area. The return rate of maiden salmon to a second spawning varied between 1 and 5% for small salmon and 4 to 17% for large salmon (mostly 2SW), respectively. In terms of numbers, from 0 to 72 small salmon and 107 to 547 large salmon would return for a second spawning in any given year.

Returns of salmon to River Philip and West River (Ant.) are lower than returns to the Margaree River. If we assume that the spawner estimates for River Philip vary between the values estimated for 1996 and1999 (506 to 1,084 fish), that the returns are mostly large salmon and that the return rates are similar to the Margaree River, then the number of repeat spawners returning to River Philip would vary between 20 and 86 fish from a total of 506 spawners in 1996 and from 43 to 184 fish out of 1,084 spawners in 1999.

IMPACTS OF A POTENTIAL KELT FISHERY

There are no positive benefits to Atlantic salmon of a kelt fishery however, a kelt fishery is expected to have minimal impacts on the stocks in River Philip and West River (Ant.). The fish have spawned the previous fall, the fertilized eggs are incubating in the substrate and water temperatures are cool in the spring.

Studies on incidental mortalities from catch and release suggest that mortality is low at cold water temperatures. Brobbel et al. (1996) demonstrated a smaller physiological disturbance, a more rapid recovery and no mortality in kelts angled when compared to bright salmon. However, a study conducted on Atlantic salmon kelts in Norway showed a 4% mortality rate and a 1-month delay in migration (Halttunen et al. 2010).

Generally, angling catches are higher in the spring than in the fall depending on water conditions. The level of angling activity and water conditions (e.g. discharge level) dictates the level of angling pressure on the kelts. There has been a recreational kelt fishery in the Miramichi River for decades with no discernable effect on the number of repeat-spawners.

The effects of a catch and release recreational kelt fishery should be evaluated on a river-by-river basis. The composition of repeat-spawners in the population, environmental conditions and human impacts will vary by river and should all be taken into consideration during the science advice. A logbook program for anglers should be mandatory to obtain catch data and biological characteristics to better inform on risks to conservation of such a fishery. The logbook will provide data on effort placed on the salmon population.

SOURCES OF UNCERTAINTIES

Harvest levels and catches of salmon from aboriginal fisheries and recreational fisheries have been incomplete or undocumented. The aboriginal fisheries include large salmon harvests in the FSC allocations; information important to determine if conservation requirements have been met because the egg requirements are calculated for large salmon. Recreational anglers receive a report stub with their salmon license. It is mandatory that the anglers return their license stubs even if they did not fish. However, return rate of license stubs by recreational anglers have been less than 50% even with a reminder letter.

In SFA 18, there were no counts of adult salmon or recent mark-recapture experiments to determine population sizes and status. The assessments conducted for the Margaree River were based on a mark-recapture experiment conducted during 1988 to 1996 in conjunction with recreational catch and effort data. Since 1997, only the recreational angling statistics have been used in the model with the catchability coefficient developed during 1988 to 1996 assumed to still be appropriate. In rivers of SFA 18A, there are no estimate of adult salmon returns to compare with the conservation requirements in those rivers. A mark-recapture experiment on an index river in SFA 18A would be required to develop a population model and assess stock status. Recreational angling statistics were used as indices of abundance. Juvenile surveys are

conducted on these rivers but the data provides an indication of spawning escapement the previous year.

Median values are presented in this document however, it is important to note that large uncertainties are associated with the estimates (included as credibility intervals). The median values do not represent the exact number of fish that returned. The assumed catch rate used to estimate adult returns to the Margaree River, and SFA 18, is high and should be verified to confirm the values.

ACKNOWLEDGMENTS

The results presented in this document were based on data collected over many years. The successful collection of the data involved many individuals. I would like to thank the following individuals for their help with the juvenile surveys during years 2008 to 2012: Yvette Cyr, Peter Hardie, Janice Fennell, Dave Moore, Samuel Ouellette, and Maria Thistle. The smolt study on River Philip would not have been possible without the help of many members of the Cumberland County River Enhancement Association. In the Fisheries Impacts section, Gérald Chaput wrote the part titled "Estimates of losses of salmon in fisheries (in rivers, estuaries and high seas)". Scott Douglas and Gérald Chaput provided editorial review of a draft of this manuscript.

REFERENCES

Breau, C., and Chaput, G. 2012. Analysis of catch options for aboriginal and recreational fisheries for Atlantic salmon from the Margaree River (Nova Scotia) for 2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/093. iv + 49 p.

Breau, C., and Ripley, D.W. 2012. Fish monitoring in River Philip (Nova Scotia) during spring 2011 with a focus on the Atlantic salmon (*Salmo salar*) smolt migration. Can. Tech. Rep. Fish. Aquat. Sci. 2974: v + 25 p.

Breau, C., Chaput, G., Leblanc, P.H., and Mallet, P. 2009. Information on Atlantic salmon (*Salmo salar*) from Salmon Fishing Area 18 (Gulf Nova Scotia) of relevance to the development of a COSEWIC status report. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/076. iv + 53 p.

Breau, C., Chaput, G., and LeBlanc, P. 2010. The migration of Atlantic salmon (*Salmo salar*) smolts from the Margaree River, Nova Scotia, 2004 to 2009. Can. Tech. Rep. Fish. Aquat. Sci. 2899: iv + 59 p

Brobbel, M.A., Wilkie, M.P., Davidson, K., Kieffer, J.D., Bielak, A.T., and Tufts, B.L. 1996. Physiological effects of catch and release angling in Atlantic salmon (*Salmo salar*) at different stages of freshwater migration. Can. J. Fish. Aquat. Sci. 53: 2036-2043.

CAFSAC. 1991a. Definition of conservation for Atlantic salmon. Can. Atl. Fish. Sci. Advis. Comm. Adv. Doc. 91/15.

CAFSAC. 1991b. Quantification of conservation for Atlantic salmon. Can. Atl. Fish. Sci. Advis. Comm. Adv. Doc. 91/16.

Chaput, G.J., and Claytor, R.R. 1989. Electrofishing surveys for Atlantic salmon from Margaree River, Nova Scotia, 1957 to 1987. Can. Data. Rep. Fish. Aquat. Sci. No. 736. iv + 76.

Chaput, G., and Jones, R. 1991a. Assessment of Atlantic salmon (*Salmo salar*) in the Margaree River, Nova Scotia 1990. DFO CAFSAC Res. Doc. 91/3. 31p.

Chaput, G., and Jones, R. 1991b. Evaluating spawning requirements, returns, escapements and surpluses to conservation levels of Atlantic salmon for selected Gulf Nova Scotia rivers. DFO CAFSAC Res. Doc. 91/73. 23p.

Chaput, G,. and Jones, R. 1994. Mainland Nova Scotia Atlantic salmon (*Salmo salar*) stock status. DFO Atlantic Fisheries Res. Doc. 94/8. 49p .

Chaput, G., Jones, R. and Forsyth, L. 1992. Assessment of Atlantic salmon in the Margaree River, Nova Scotia, 1991. DFO CAFSAC Res. Doc. 92/26. 40p.

Chaput, G.J., Jones, R., Forsyth, L., and LeBlanc, P. 1993. Assessment of Atlantic salmon in the Margaree River, Nova Scotia, 1992. DFO Can. Stock Assess. Sec. Res. Doc. 93/14. 64 p.

Chaput, G., Jones, R., Forsyth, L., and LeBlanc, P. 1994. Assessment of the Atlantic salmon (*Salmo salar*) stock of the Margaree River, Nova Scotia, 1993. DFO Atl. Fish. Res. Doc. 94/6. 64 p.

Chaput, G., Moore, D., and Peterson, D. 2005. Predicting Atlantic salmon (*Salmo salar*) juvenile densities using catch per unit effort open site electrofishing. Can. Tech. Rep. Fish. Aquat. Sci. 2600. v + 25 p.

Chaput, G., Cameron, P., Moore, D., Cairns, D., and LeBlanc, P. 2006a. Stock status of Atlantic salmon (*Salmo salar* L.) from rivers of the Gulf Region, SFA 15 to 18. DFO Can. Stock Assess. Sec. Res. Doc. 2006/023. vi + 31 p.

Chaput, G., Dempson, J.B., Caron, F., Jones, R., and Gibson, J. 2006b. A synthesis of life history characteristics and stock grouping of Atlantic salmon (*Salmo salar* L.) in eastern Canada. DFO Can. Stock Assess. Sec. Res. Doc. 2006/015. iv + 47 p.

Chiasson, G., Gallant, P.A., and P. Mallet. 2002. Traditional and local knowledge: Estuarine fisheries by-catch in the southern Gulf of St. Lawrence; ecosystem based fisheries management considerations. Can. Man. Rep. Fish. Aquat. Sci. No. 2613. vi + 45p.

Claytor, R.R. 1996. Weekly fish counts from in-river traps, counting fences, barrier pools, and fishways in southern Gulf of St. Lawrence, from 1952 - 1993. Can. Data Rept. Fish. Aquat. Sci. No 982. xiv + 143p.

Claytor, R.R., and Chadwick, E.M.P. 1985. Assessment of Atlantic salmon, *Salmo salar*, in the Margaree River, Nova Scotia, 1985. DFO CAFSAC Res. Doc. 85/103. 25 p.

Claytor, R.R., and Chaput, G. 1988. Assessment of Atlantic salmon (*Salmo salar*) in the Margaree River, 1988. DFO CAFSAC Res. Doc. 88/75. 43 p.

Claytor, R.R., and Jones, R. 1990. Assessment of Atlantic salmon (*Salmo salar*), in the Margaree River, 1989. DFO CAFSAC Res. Doc. 90/27. 22 p.

Claytor, R.R., and Leger, C. 1986. Assessment of Atlantic salmon, *Salmo salar*, in the Margaree River, Nova Scotia, 1986. DFO CAFSAC Res. Doc. 86/93. 21 p.

Claytor, R.R., Chaput, G.J., and Lutzac, T.G. 1987. Assessment of Atlantic salmon, (*Salmo salar*), in the Margaree River, 1987. DFO CAFSAC Res. Doc. 87/105. 36 p.

Claytor, R.R., Jones, R., LeBlanc, P., and Chaput, G. 1995 . Mainland Gulf Nova Scotia Atlantic salmon (*Salmo salar*) stock status, 1994. DFO Atlantic Fisheries Res. Doc. 95/15. 33 p.

Clément, M., Chaput, G., and Leblanc, P. 2007. Atlantic salmon (*Salmo salar*) smolt migration from the Margaree River, 2001-2003. Can. Tech. Rep. Fish. Aquat. Sci. no. 2693: x + 60 p.

COSEWIC. 2010. COSEWIC assessment and status report on the Atlantic Salmon *Salmo salar* (Nunavik population, Labrador population, Northeast Newfoundland population, South Newfoundland population, Southwest Newfoundland population, Northwest Newfoundland population, Quebec Eastern North Shore population, Quebec Western North Shore population, Anticosti Island population, Inner St. Lawrence population, Lake Ontario population, Gaspé-Southern Gulf of St. Lawrence population, Eastern Cape Breton population, Nova Scotia Southern Upland population, Inner Bay of Fundy population, Outer Bay of Fundy population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xlvii + 136 p.

DFO. 1984. 1984 Atlantic salmon management plan: guiding principles. DFO Report 26p.

DFO. 2008. Atlantic salmon integrated management plan 2008-2012. Gulf Region. 45 p.

DFO. 2012. Stock status of Atlantic salmon (*Salmo salar*) in DFO Gulf Region (Salmon Fishing Areas 15 to 18). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/040.

Halttunen, E., Rikardsen, A.H., Thorstad, E.B., Næsje, T.F., Jensen, J.L.A., and Aas, O. 2010. Impact of catch-and-release practices on behavior and mortality of Atlantic salmon (*Salmo salar* L.) kelts. Fisheries Research 105: 141-147.

ICES. 2007. Report of the Working Group on North Atlantic Salmon (WGNAS), 11-20 April 2007 ICES Headquarters, ICES CM 2007/ACFM: 13. 253 p. (http://www.ices.dk/reports/ACFM/2007/WGNAS/WGNAS07.PDF)

ICES. 2011. Report of the Working Group on North Atlantic Salmon (WGNAS), 22-31 March 2011 Copenhagen, Denmark. ICES CM 2011/ACOM: 09. 286 p. (http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=35)

Landry, D., Chaput, G., and Bridgland, J. 2005. Stock status of Atlantic salmon (*Salmo salar*) in the Cheticamp River, Cape Breton Highlands National Park, Nova Scotia, for 2004. DFO Can. Stock Assess. Sec. Res. Doc. 2005/022. ii + 19 p.

LeBlanc, P.H., and Chaput, G.J. 2003. Electrofishing surveys for Atlantic salmon (*Salmo salar* L.) from the Margaree River, Nova Scotia, 1988 to 2000. Can. Data Rep. Fish. Aquat. Sci. No. 1128. vi + 39 p.

LeBlanc, P.H., Jones, R.A., and Chaput, G. 2005. Biological Characteristics of Adult Atlantic Salmon (*Salmo salar* L.) from the Margaree River, Nova Scotia, 1987 to 1996. Can. Data Rep. Fish Aquat. Sci 1172: vi + 28 p.

Locke, A., Jones, R., Pickard, R., Atkinson, G., and Davidson, K. 1993. Status of Atlantic salmon stocks in salmon fishing areas 15, 16, 17 and 18. DFO Atlantic Fisheries Res. Doc. 93/28. 20 p.

Marshall, T.L. 1982. Background and management alternatives for salmon of the Margaree River: a working document for the selection of stock enhancement strategies .Fisheries and Oceans, Halifax, NS.. Mimeo. 117pp. Available from: DFO Science Branch, P.O. Box 5030, Moncton, NB, E1C9B6.

Marshall, T.L., Jones, R., LeBlanc, P., and Forsyth, L. 1996. Status of Atlantic salmon stocks of the Margaree and other selected rivers of Cape Breton Island, 1995. DFO Atl. Fish. Res. Doc. 96/142. 81 p.

Marshall, T.L., Forsyth, L., Jones, R., LeBlanc, P., and Rutherford, K. 1997. Status of Atlantic salmon stocks in selected rivers of Cape Breton Island, 1996. DFO Can. Stock Assess. Sec. Res. Doc. 97/23. xi + 70 p.

Marshall, T.L., Rutherford, K., LeBlanc, P., and Jones, R. 1999. Follow-up to the assessment of Atlantic salmon in selected rivers of Cape Breton Island, 1998. DFO Can. Stock Assess. Sec. Res. Doc. 1999/108. 57 p.

Marshall, T.L., LeBlanc, P.H., Rutherford, K.A., and Jones, R.A. 2000. Assessments of Atlantic salmon stocks in selected rivers of Cape Breton Island 1999. DFO Can. Stock Assess. Sec. Res. Doc. 2000/008. 34 p.

O'Neil, S.F., Longard, D.A., and Harvie, C.J. 1996. Stock status of Atlantic salmon on the Northumberland Strait, Nova Scotia area rivers in 1995. DFO Atl. Fish. Res. Doc. 96/127. 45 p.

O'Neil, S.F., Longard, D.A., and Harvie, C.J. 1997. Atlantic salmon (*Salmo salar* L.) stock status on rivers in the Northumberland Strait, Nova Scotia area, in 1996. DFO Can. Stock Assess. Sec. Res. Doc. 1997/22. iii + 45 p.

O'Neil, S.F., Rutherford, K.A., and Aitken, D. 2000. Atlantic salmon (*Salmo salar*) stock status on rivers in the Northumberland Strait, Nova Scotia area, in 1999. DFO Can. Stock Assess. Sec. Res. Doc. 2006/023. iii + 39 p.

Zippin, C. 1956. An evaluation of the removal method of estimating animal populations. Biometrics 12: 163-189.

Table 1. Atlantic salmon harvest allocations to aboriginal communities in rivers of Nova Scotia flowing into the Gulf of St. Lawrence in 2011.

Aboriginal community	River	Allocation		
		1SW	MSW	
Pictou Landing	East (Pictou)	30	70	
	West (Pictou)	25	37	
	River John	20	10	
	Merigomish Hbr.	10	30	
	Margaree	5	10	
Eskasoni	Margaree	26	65	kelts fishery as required
Membertou	Margaree	26	65	
Wagmatcook	Margaree	26	65	
Waycobah	Margaree	26	65	
Chapel Island	Margaree	26	65	
Nova Scotia Native Council	SFA 18			1,820 fish [a]
Total		220	482	

[a] combination of small and large salmon

Table 2. Recreational effort (rod days) and catch of Atlantic salmon by size group in Gulf Nova Scotia rivers, 1984 to 2011. SFA 18B refers to rivers in Cape Breton and SFA18A refers to rivers on mainland Nova Scotia.

	SFA 18A				SFA 18B			
Year	Effort - rod days	Small salmon kept	Small salmon catch	Large salmon released	Effort - rod days	Small salmon kept	Small salmon catch	Large salmon released
1984	943	54	60	104	6,553	197	248	334
1985	1,122	67	96	434	7,955	408	523	1,259
1986	2,822	299	389	1,727	10,298	657	790	2,702
1987	3,998	238	304	1,091	12,904	827	979	1,907
1988	4,003	374	487	1,160	14,269	772	902	2,024
1989	4,556	255	363	1,514	13,537	450	582	1,753
1990	4,201	417	562	830	14,217	502	655	1,579
1991	5,332	333	494	1,586	13,696	585	784	1,919
1992	4,240	390	560	1,344	15,242	589	731	2,103
1993	5,685	271	424	1,232	15,783	562	790	1,135
1994	3,783	141	219	549	13,657	293	437	1,488
1995	4,092	247	365	541	12,436	207	353	1,115
1996	5,834	480	857	2,117	9,373	290	1,259	1,989
1997	2,415	137	215	452	9,910	195	330	2,133
1998	4,384	268	455	781	10,209	212	359	1,371
1999	4,145	282	523	1,058	7,956	200	321	819
2000	3,263	134	275	382	7,383	137	276	705
2001	1,009	15	46	59	7,570	146	373	862
2002	3,226	128	337	282	7,418	163	370	626
2003	2,413	82	193	391	7,485	187	347	1,171
2004	2,933	180	408	565	7,920	253	523	1,412
2005	3,268	133	434	705	9,475	215	439	1,374
2006	3,705	102	281	620	9,158	258	458	1,285
2007	3,048	78	291	273	8,723	200	342	786
2008	3,356	132	485	542	8,658	331	684	1,391
2009	4,506	23	280	968	8,357	52	179	1,040
2010	3,996	129	421	705	7,361	185	444	1,264
2011	5,959	213	991	2,547	10,098	250	707	2,924
5-yr average (2006-2010)	3,722	93	352	622	8,451	205	421	1,153

Table 3. The conservation egg requirements and spawner requirements for the Gulf Nova Scotia rivers of SFA 18.

River	Egg requirements (x 1,000)	Large salmon
Cape Breton (SFA 18B)		
Margaree River	6,714	1,036
Mainland Nova Scotia (SFA 18A)		
Afton River	45	14
Barney's River	511	79
East River, Pictou	1,750	271
French River, Colchester	673	104
French River, Pictou	417	65
Middle River, Pictou	709	110
Pomquet River	185	57
Pugwash River	593	92
River John	954	148
River Philip	2,309	358
South River	228	70
Sutherlands River	160	25
Tracadie (Monastery) River	126	39
Wallace River	1,495	232
Waugh River	752	116
West River, Antigonish	1,153	353
West River, Pictou	798	124
Total	19,572	3,293

Table 4. Estimates of relative year class survival rates and return rates of smolts to small salmon and large salmon (mostly 2SW) in the Margaree River during the period of 2001 to 2011. Fry and parr densities are from Breau et al. (2009). Smolt data for 2002 and 2003 are from Clément et al. (2007). Density is expressed as fish per 100 m^2 of habitat.

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Smolt run size estimates		63,200	83,050	105,800	94,200	113,700	112,400	128,800	96,800
95% C.I. range		28,623	13,969	15,588	14,473	14,645	20,815	27,631	20,422
Fry density	57.1	93.9	21.6	171.6	189.8	120.1	115.8	85.9	25.5
Parr density	77.8	50.6	60.6	46.5	112.4	95.9	82.1	55.9	23.8
Parr per fry		88.6%	64.6%	215.3%	65.5%	50.5%	68.4%	48.3%	27.7%
Smolt per unit habitat		2.3	3.0	3.8	3.4	4.1	4.0	4.6	3.5
Smolt per parr (parr year +1)		2.9%	5.9%	6.2%	7.2%	3.6%	4.2%	5.6%	6.2%
Small salmon returns (smolt year+1)		918	1,300	915	1,024	845	1,488	334	960
Return rate of small salmon		1.5%	1.6%	0.9%	1.1%	0.7%	1.3%	0.3%	1.0%
Large salmon returns (smolt year +2)		3,947	3,248	3,143	2,198	3,380	2,324	3,120	5,204
Return rate of large salmon		6.2%	3.9%	3.0%	2.3%	3.0%	2.1%	2.4%	5.4%

Table 5. Yearly composition of smolt catches by cohort and the smolts produced by spawners in the Margaree River for the 1999 to 2006 year classes. Total smolt numbers in italic indicate incomplete cohorts.

	Smolt age					MSW	Smolts per
Year class	2	3	4	5	Total	spawners	spawners
1995						2,168	
1996				0		4,741	
1997			3,063	0		4,997	
1998		36,472	3,384	1,343		3,014	
1999	23,665	46,139	5,374	1,144	76,322	2,294	33
2000	33,528	57,770	8,772	0	100,069	2,182	46
2001	41,312	51,104	5,494	0	97,911	2,528	39
2002	33,180	37,024	3,372	0	73,576	1,828	40
2003	71,182	55,975	3,349	369	130,875	3,561	37
2004	53,053	62,339	1,108		*116,500*	3,954	29
2005	62,983	40,641			*103,624*	3,237	32
2006	54,681				*54,681*	3,135	
2007						2,201	
2008						3,403	

Table 6. The numbers and percentages of small and large salmon of wild-origin and hatchery-origin (clipped adipose fin) that were reported caught by recreational anglers in the Margaree River during 2000 to 2011. The data were collected by anglers who volunteered to participate in a logbook program in Nova Scotia.

	Small salmon			Large salmon		
Year	Wild origin	Adipose-fin clipped	Percentage with clipped fin	Wild origin	adipose-fin clipped	Percentage with clipped fin
2000	26	1	4	85	0	0
2001	27	3	10	74	2	3
2002	41	1	2	59	1	2
2003	22	4	15	59	32	35
2004	33	0	0	92	3	3
2005	23	2	8	89	1	1
2006	26	5	16	61	1	2
2007	13	0	0	30	0	0
2008	37	1	3	51	1	2
2009	3	0	0	34	1	3
2010	15	1	6	33	0	0
2011	41	1	2	113	2	2

Table 7. Results of a by-catch survey conducted with fishery officers. Table is modified from Chiasson et al. (2002). Values express quantities based on qualitative observations and do not represent absolute numbers. Blanks indicate that no value was assigned to the fishery. 1=minimal, 2=moderate and 3=large quantities.

	Fisheries		
River system	gaspereau box nets	smelt box nets	eel traps or pots
SFA18B			
Margaree River			0
Mabou Harbour			0
Little Judique Hbr.			0
SFA18A			
West River (Ant.)	0	0	1
Pomquet R.			1
Pictou Hbr.	1		
Merigomish Hbr.			2
R. John		0	
R. Philip	1	0	
Wallace Bay	0	0	
Pugwash Hbr.	1	2	
Percentage of 0	40	80	50
Percentage of 1	60	0	33
Percentage of 2	0	20	17
Percentage of 3	0	0	0

Table 8. Estimated 2SW returns, estimated catches at West Greenland originating from Gulf Region SFAs and the proportion of the 2SW returns destined for SFAs in Gulf Region which were harvested in the West Greenland fishery.

	2SW Returns to				West Greenland NA 1SW catch		Estimated corrected catch from			Proportion lost from		
Assessment year	North America (NA)	SFA 15	SFA 16	SFA 18	Estimated	Corrected to NA	SFA 15	SFA16	SFA18	SFA 15	SFA 16	SFA 18
1970	166700	9405	44330	5790								
1971	110600	4101	28350	2336	275,000	203,725						
1972	139700	7367	36370	5364	206,100	152,683	10,743	53,039	7,822	0.59	0.59	0.59
1973	146400	9123	33510	4809	259,400	192,168	9,515	34,948	5,015	0.51	0.51	0.51
1974	200300	10920	49640	6213	215,000	159,276	10,477	47,625	5,961	0.49	0.49	0.49
1975	166700	6146	32640	3898	270,500	200,391	5,872	31,186	3,724	0.49	0.49	0.49
1976	161800	10870	25600	3212	157,000	116,308	13,463	31,706	3,978	0.55	0.55	0.55
1977	218200	13640	61540	4726	198,600	147,126	7,271	32,803	2,519	0.35	0.35	0.35
1978	150700	8091	22760	5431	144,400	106,974	7,899	22,220	5,302	0.49	0.49	0.49
1979	74950	2004	7904	1647	197,300	146,163	2,860	11,281	2,351	0.59	0.59	0.59
1980	222800	10550	41780	4451	168,200	124,606	6,921	27,409	2,920	0.40	0.40	0.40
1981	153600	5966	15210	3127	224,200	166,091	4,840	12,339	2,537	0.45	0.45	0.45
1982	148500	5318	31440	5019	202,900	150,312	5,948	35,164	5,614	0.53	0.53	0.53
1983	118700	4363	22380	4486	37,330	27,655	5,525	28,340	5,681	0.56	0.56	0.56
1984	115700	4711	21870	2984	45,140	33,441	1,126	5,227	713	0.19	0.19	0.19
1985	132600	7156	26180	2694	137,800	102,085	1,805	6,602	679	0.20	0.20	0.20
1986	160200	11630	38660	6865	171,700	127,198	7,411	24,635	4,375	0.39	0.39	0.39
1987	125900	6985	22400	5440	172,100	127,495	7,057	22,631	5,496	0.50	0.50	0.50
1988	133400	10530	25650	5328	118,100	87,491	10,064	24,515	5,092	0.49	0.49	0.49
1989	113200	6449	16310	4509	60,690	44,960	4,984	12,606	3,485	0.44	0.44	0.44
1990	117900	6343	25460	4010	72,640	53,813	2,419	9,709	1,529	0.28	0.28	0.28
1991	108500	3530	26260	5020	110,700	82,009	1,751	13,024	2,490	0.33	0.33	0.33
1992	121600	5898	26050	5000	41,470	30,722	3,978	17,568	3,372	0.40	0.40	0.40
1993	109100	2035	37830	2791	2,629	1,948	573	10,653	786	0.22	0.22	0.22
1994	96940	5857	19280	4219	2,628	1,947	119	391	86	0.02	0.02	0.02
1995	126100	4013	31420	3192	26,680	19,765	62	485	49	0.02	0.02	0.02
1996	109400	5825	15120	6990	26,900	19,928	1,062	2,732	1,263	0.15	0.15	0.15
1997	88060	3697	11380	7379	18,140	13,438	837	2,575	1,670	0.18	0.18	0.18
1998	62570	2478	8043	4450	6,010	4,452	532	1,727	956	0.18	0.18	0.18
1999	66650	2605	8858	3419	8,964	6,641	174	592	228	0.06	0.06	0.06
2000	67930	3340	9204	3248	8,253	6,114	327	900	318	0.09	0.09	0.09
2001	77910	5596	16050	3718	11,970	8,868	439	1,260	292	0.07	0.07	0.07
2002	49540	3437	7024	2737	4,482	3,320	615	1,257	490	0.15	0.15	0.15
2003	75020	5859	13380	5272	4,833	3,580	259	592	233	0.04	0.04	0.04
2004	71960	4441	14190	5878	6,035	4,471	221	706	292	0.05	0.05	0.05
2005	73690	5104	14970	4821	5,813	4,306	310	908	292	0.06	0.06	0.06
2006	69610	3763	12240	4654	6,863	5,084	233	757	288	0.06	0.06	0.06
2007	66310	6332	12030	3239	9,204	6,818	485	922	248	0.07	0.07	0.07
2008	72030	4212	8842	4933	10,500	7,779	399	837	467	0.09	0.09	0.09
2009	85990	5864	14340	3298	9,279	6,874	530	1,297	298	0.08	0.08	0.08
2010	62470	4453	10250	4075	12,190	9,031	490	1,128	448	0.10	0.10	0.10

Table 9. Sea-age spawning histories of wild Atlantic salmon captured as kelts by angling in River Philip during May 2007, 2010 and 2011. 1SW, 2SW, and 3SW are maiden spawners. C and A represent consecutive and alternate repeat spawning strategies, respectively, and occur in the temporal order shown with the first number the sea-age at maiden spawning.

Age type	2007	2010	2011
1SW	6	1	16
2SW	52	106	45
3SW	4	6	0
2C	1	1	0
2A	10	1	2
2CC	2	1	0
2AC	1	3	0
2CAC		1	0
Total	76	120	63
Proportion of 1SW	0.08	0.01	0.25
Proportion of 2SW	0.68	0.88	0.71
Proportion of 3SW	0.05	0.05	0.00
Proportion of repeat-spawners	0.18	0.06	0.03
Proportion of maiden	0.82	0.94	0.97

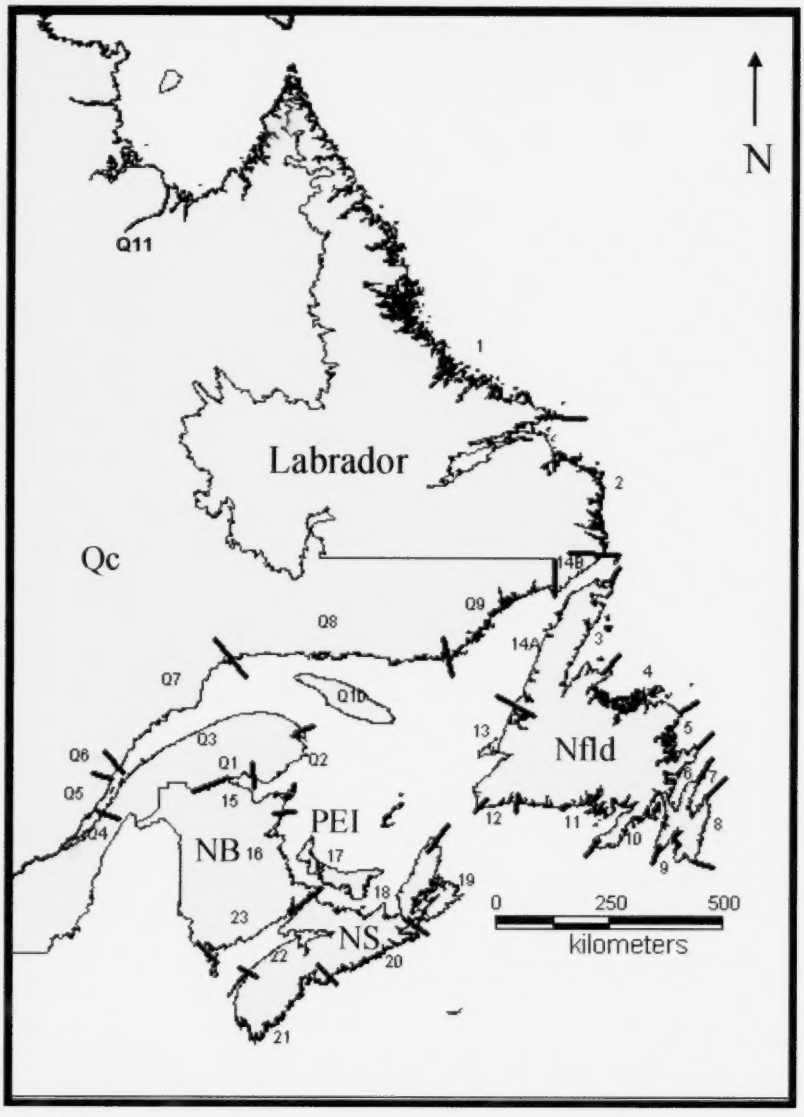

Figure 1. Salmon Fishing Areas (SFA) in eastern Canada. SFA 18 refers to rivers in Nova Scotia that flow into the Gulf of St. Lawrence.

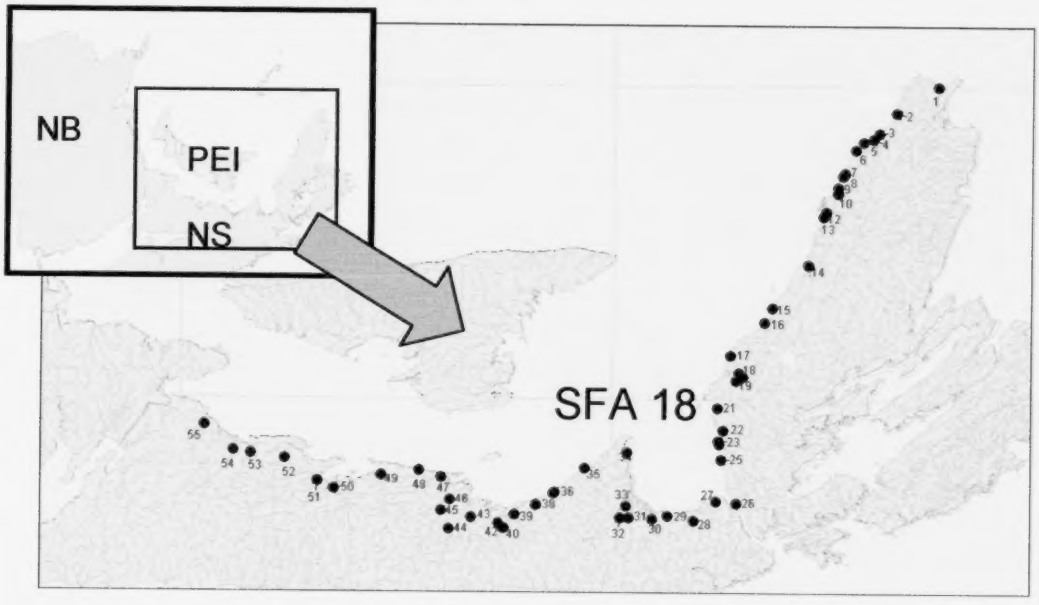

Figure 2. Rivers in Gulf Nova Scotia (Salmon Fishing Area 18) that flow into the southern Gulf of St. Lawrence. Index numbers on the map refer to river names as presented in Breau et al. (2009).

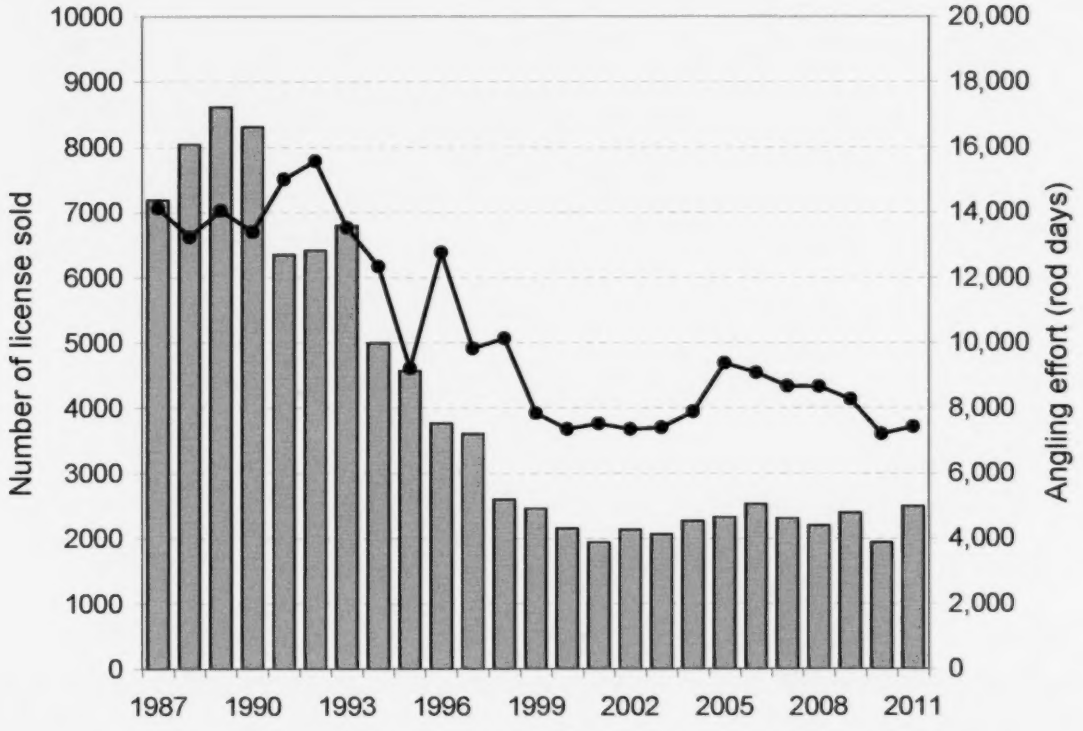

Figure 3. The number of recreational Atlantic salmon licenses sold and the annual estimated angling effort in Nova Scotia, 1987 to 2011.

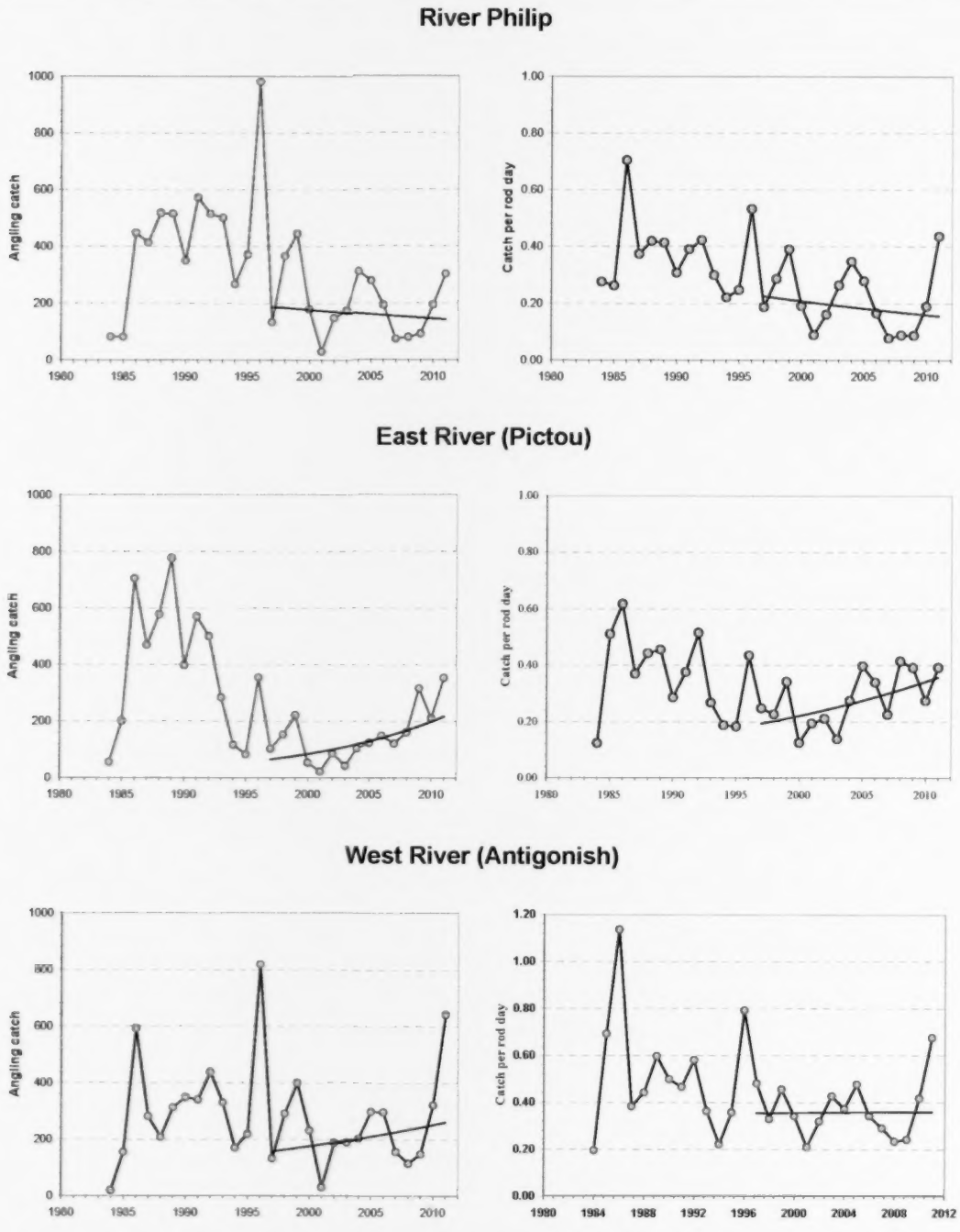

Figure 4. Angling catch of small salmon and large salmon combined (left panels) and catch per rod day (right panels) for the three index rivers flowing into the Northumberland Strait (SFA 18A), 1984 to 2011.

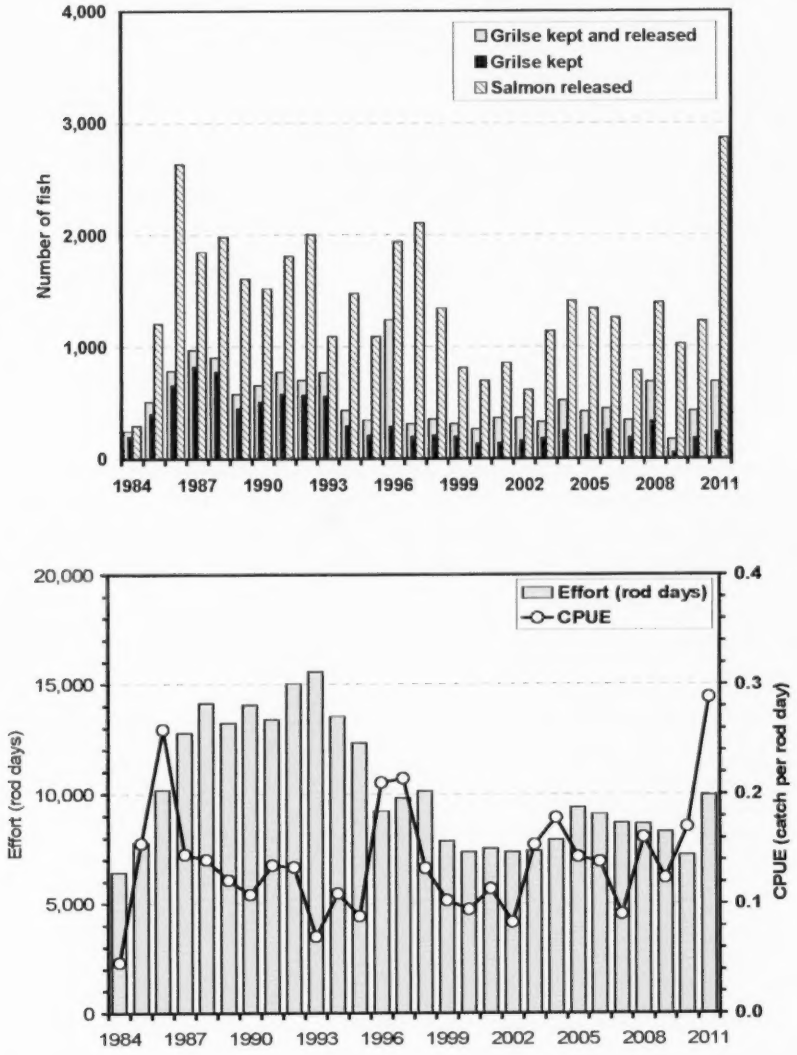

Figure 5. Upper panel: catch of small salmon (fork length < 63cm) and large salmon (fork length ≥ 63cm) Atlantic salmon in the Margaree River. Lower panel: angling effort and catch per rod day for the Margaree River, 1984 to 2011.

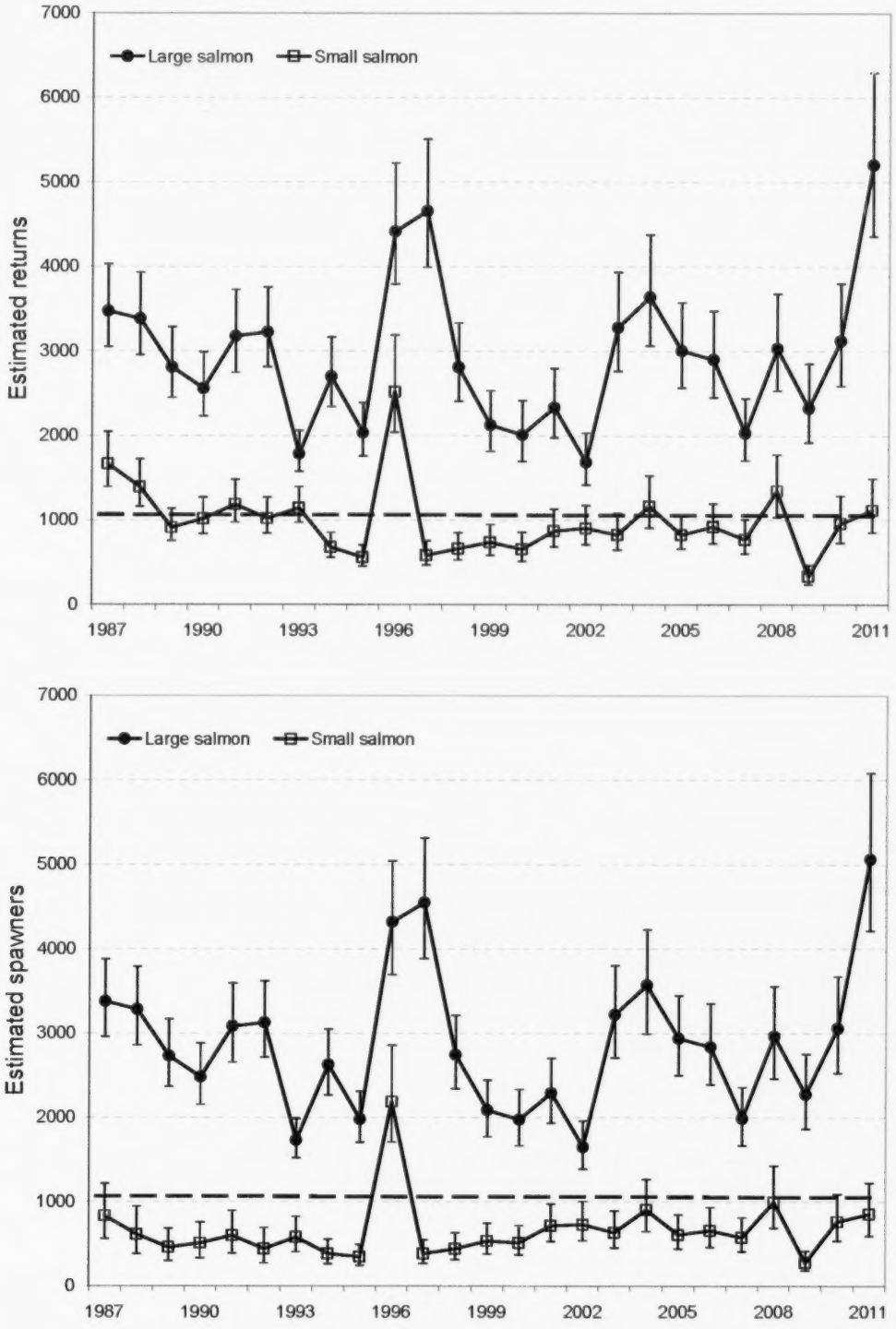

Figure 6. Estimates of returns (upper panel) and spawners (lower panel) for small and large salmon in the Margaree River during 1987 to 2011. The conservation requirement based on large salmon is depicted by the dashed line. Vertical bars represent the 2.5% and 97.5% credibility intervals.

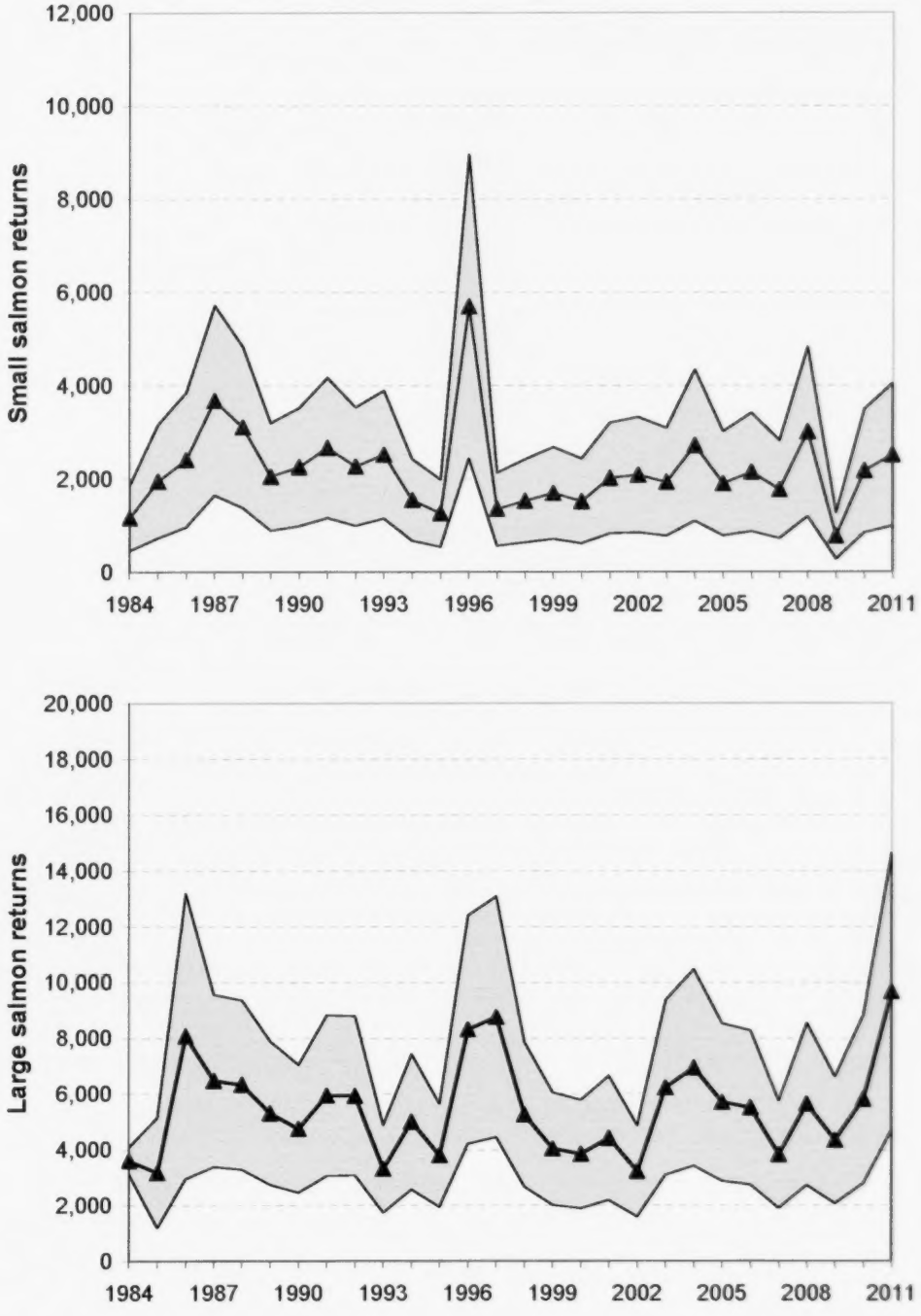

Figure 7. The median estimate of small salmon (upper panel) and large salmon (lower panel) returns in SFA 18, 1984 to 2011. The grey shaded area in each panel represents the 2.5% and the 97.5% credibility intervals.

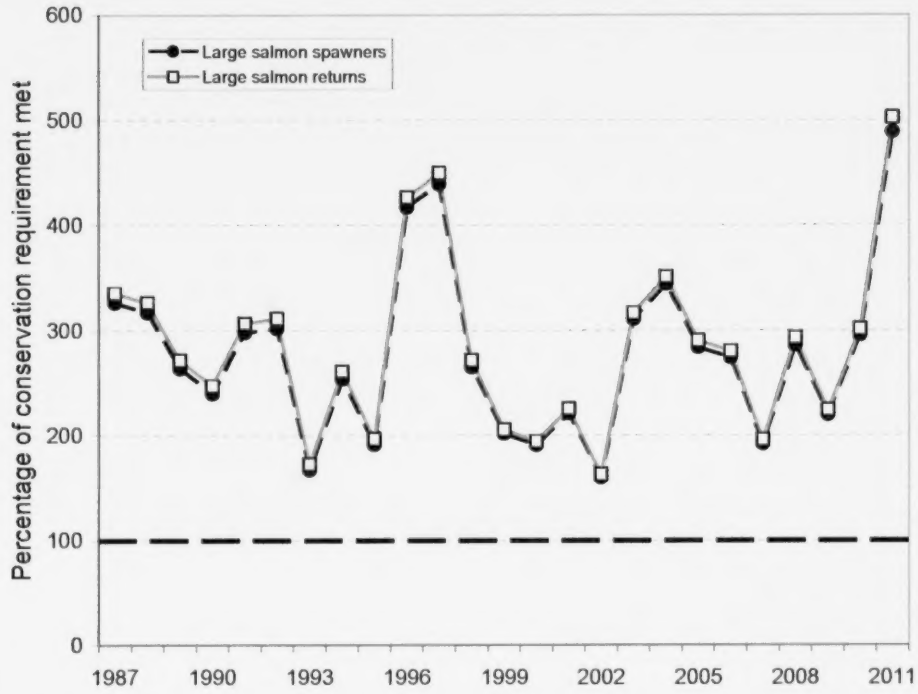

Figure 8. The number of large salmon returns and spawners relative to the conservation requirement of 1,036 large salmon for the Margaree River, 1987 to 2011. The conservation requirement is shown with a long dash line for large salmon. The conservation (egg) requirement for the Margaree River was calculated from the large salmon.

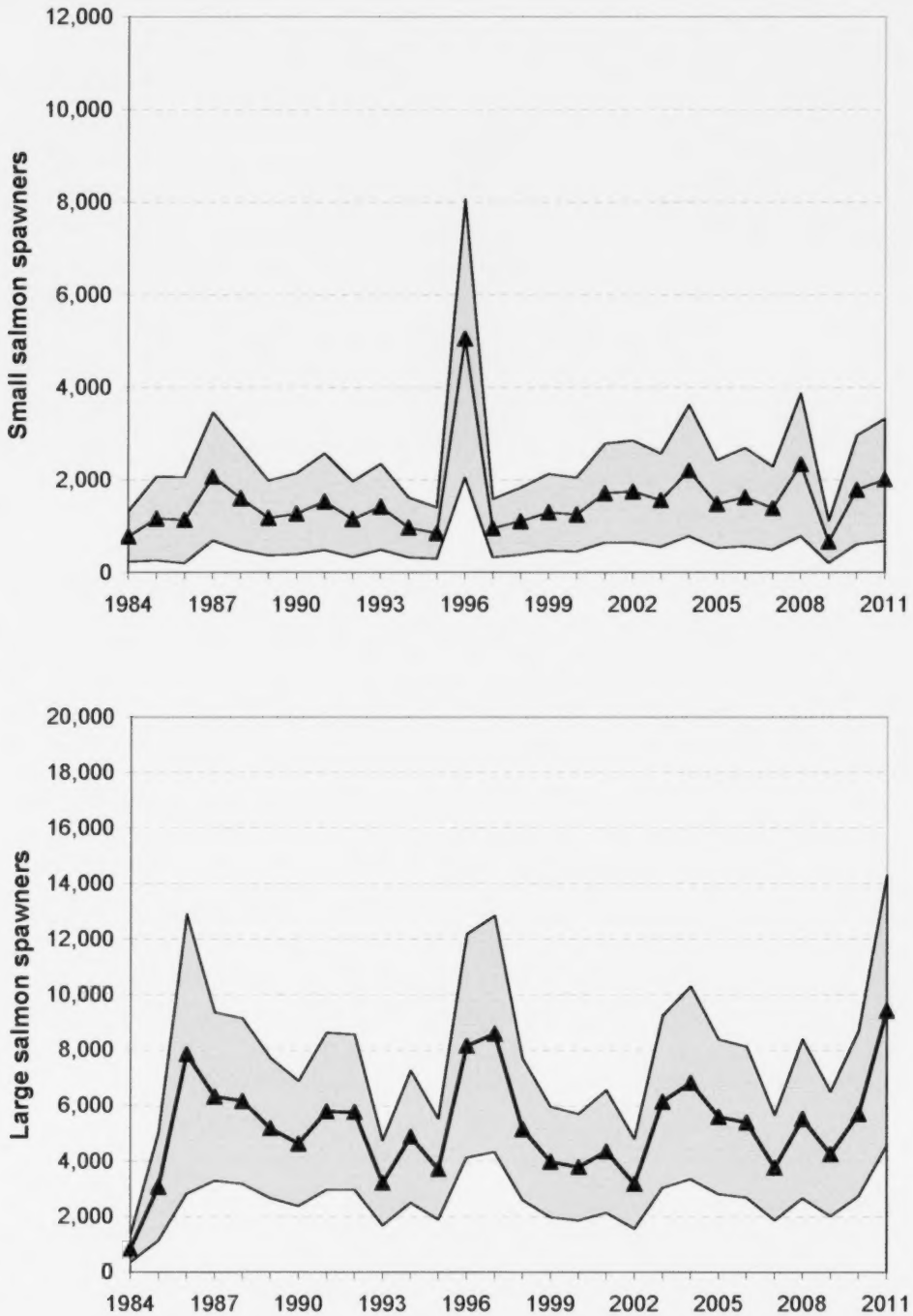

Figure 9. The median estimate of small salmon (upper panel) and large salmon (lower panel) spawners in SFA 18, 1984 to 2011. The grey shaded area in each panel represents the 2.5% and the 97.5% credibility intervals.

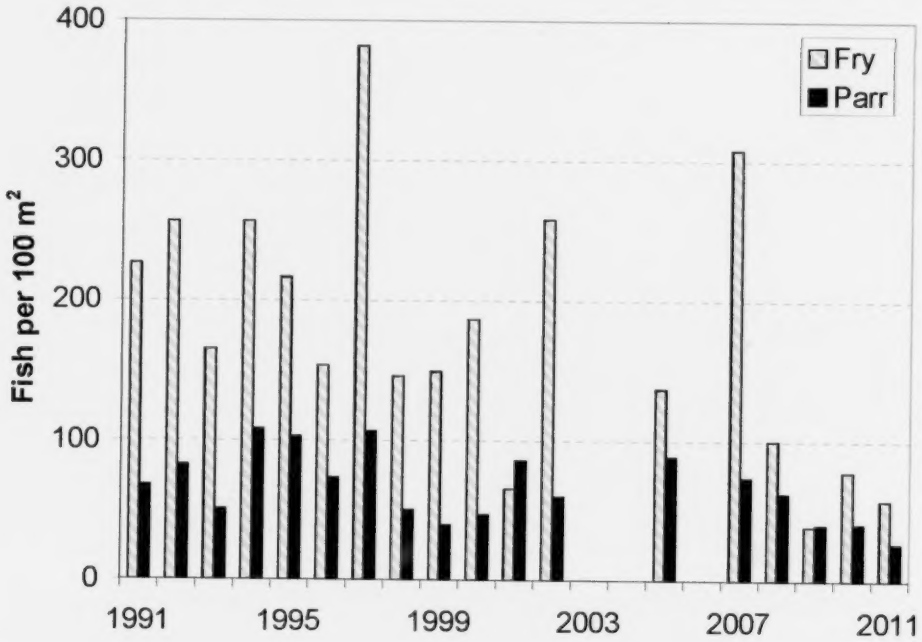

Figure 10. Density (fish per 100 m²) of fry and parr in West River (Antigonish), during 1991 to 2011.

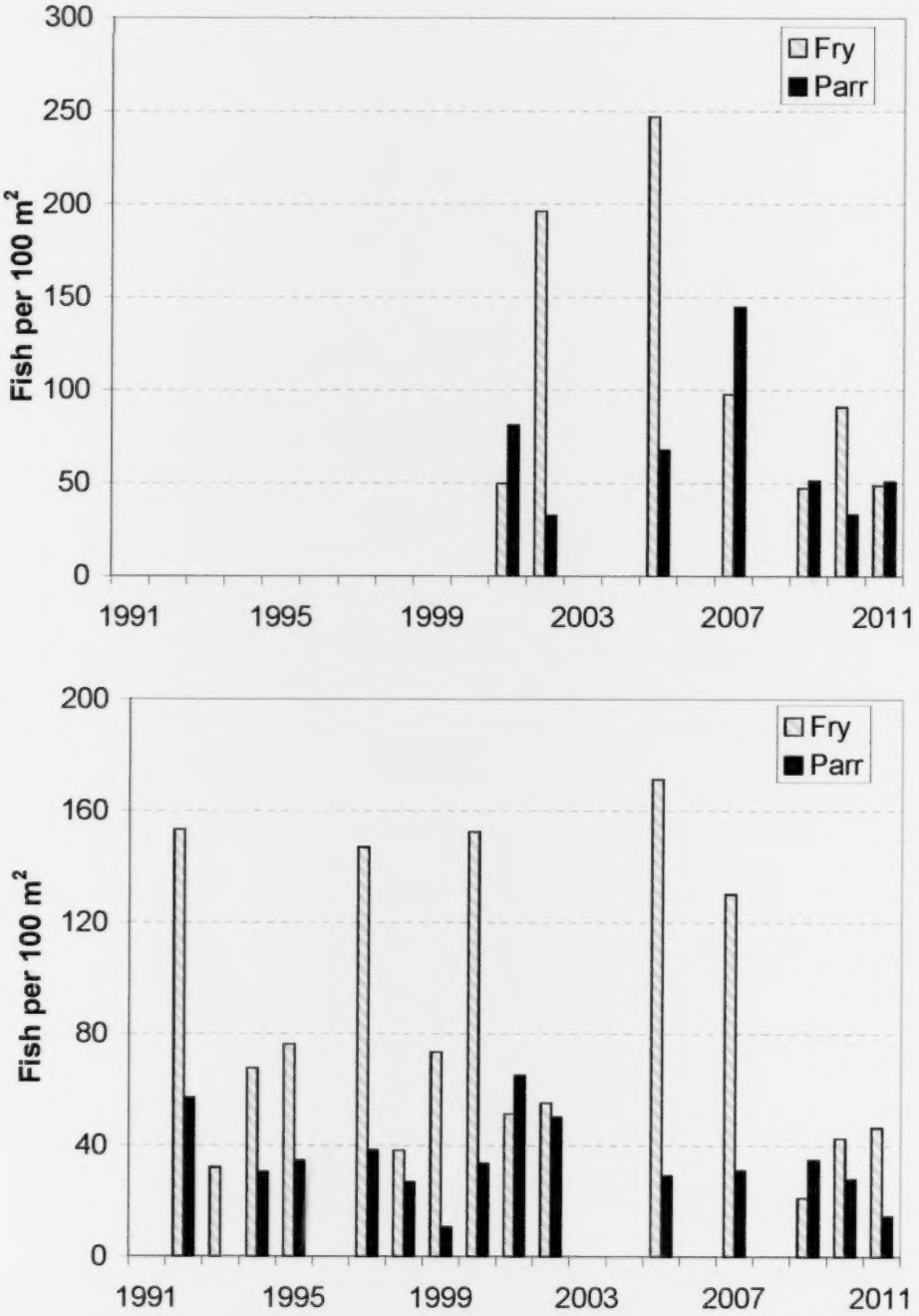

Figure 11. Density of fry and parr per 100m^2 in Barney's River (upper panel) and East River (Pictou) (lower panel), during 1991 to 2011. Note: y-axis scale differs between figures.

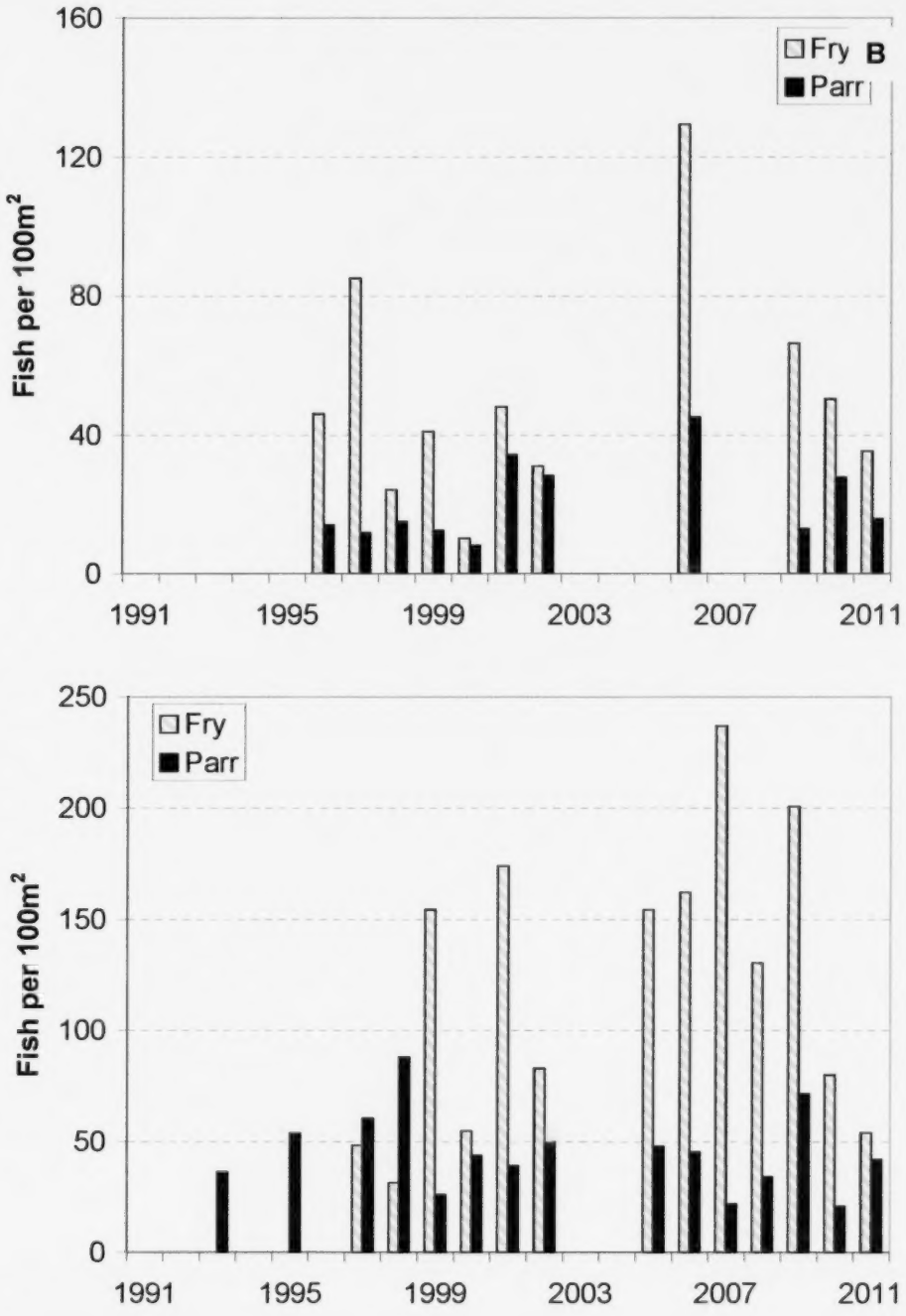

Figure 12. Density of fry and parr per 100m^2 in Wallace River (upper panel) and River Philip (lower panel) during 1991 to 2011. Note: y-axis scale differs between figures.

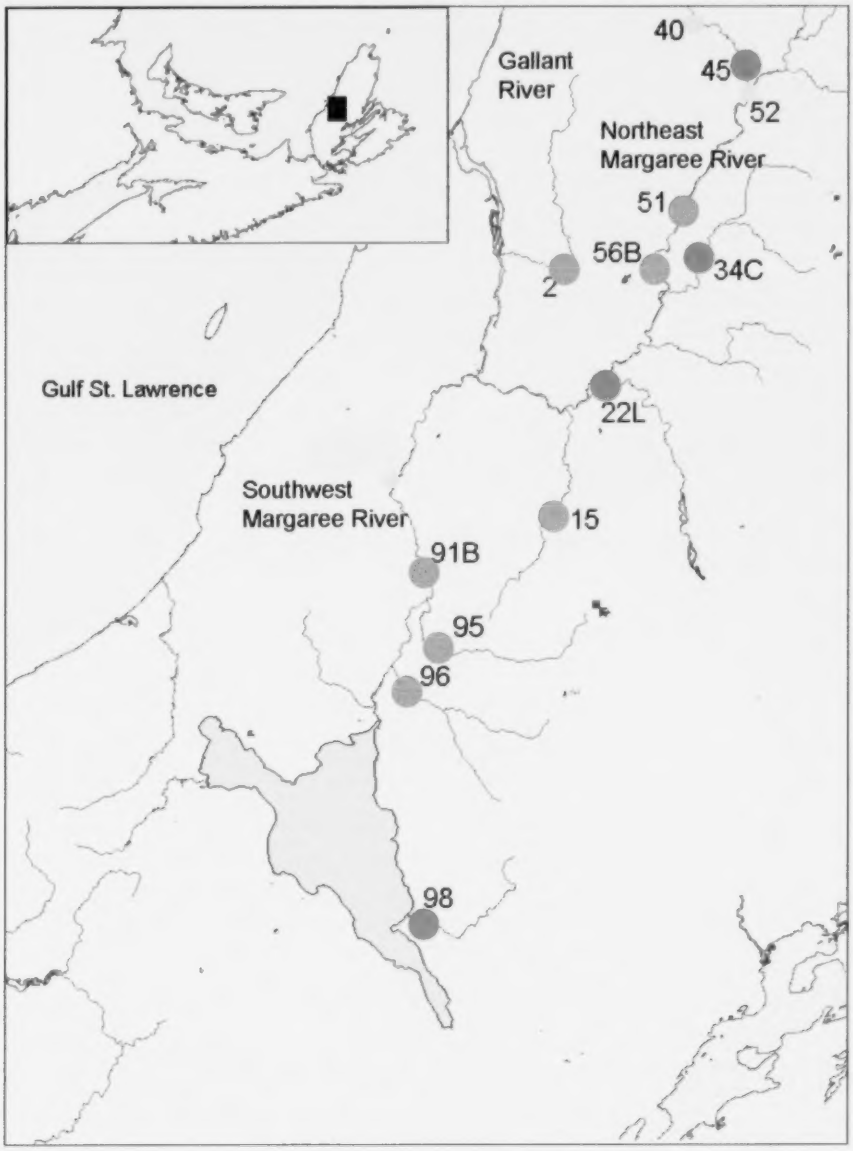

Figure 13. Presence (blue circles) and absence (red circles) of Atlantic salmon fry in the electrofishing sites surveyed in the Margaree River in September 2011.

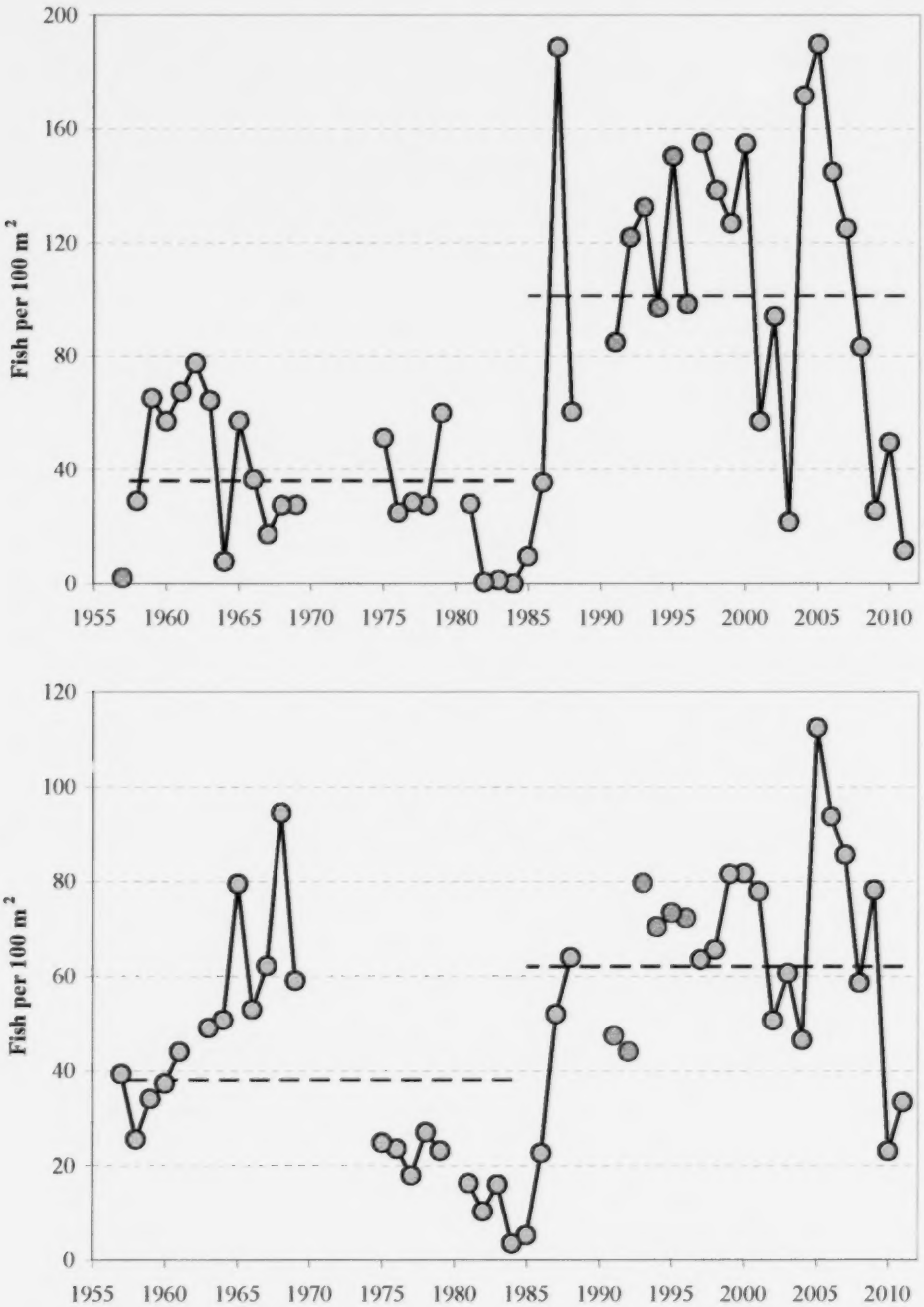

Figure 14. Densities (fish per 100m^2) of fry (upper panel) and parr (lower panel) in the Margaree River during 1957 to 2011. The long dashed lines represent the average densities prior and after 1984 when changes in the commercial and recreational fisheries began. Note: y-axis scale difference between figures.

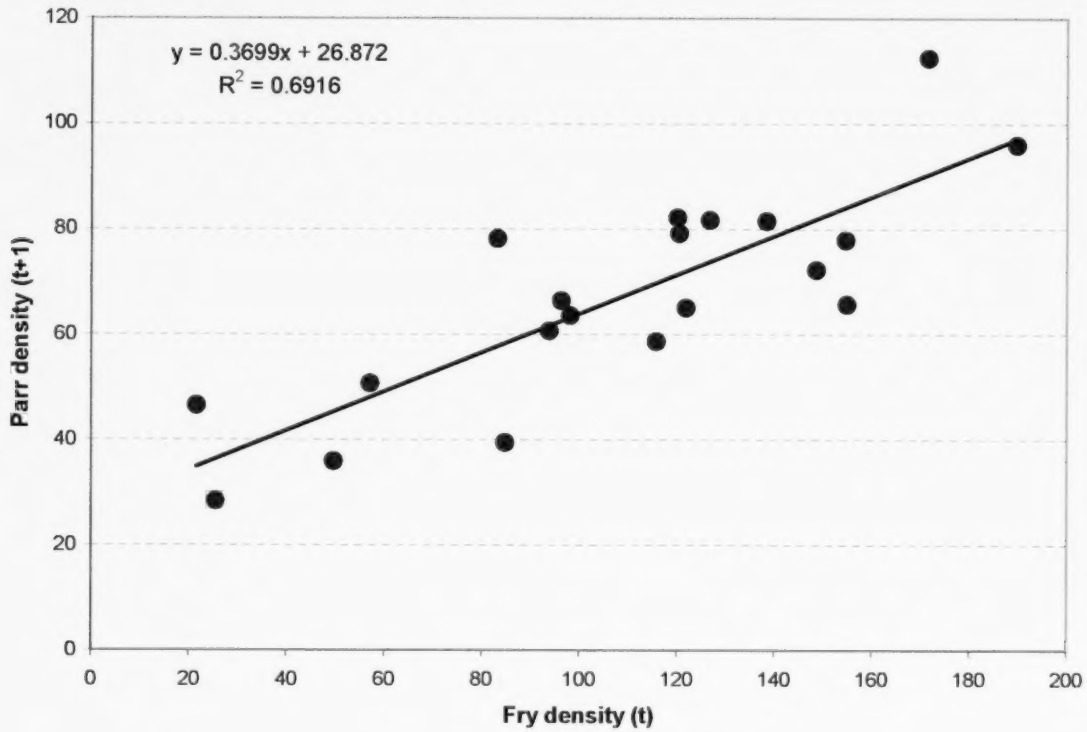

Figure 15. The relationship between average fry abundance in year (t) to average parr abundance in year (t+1) for the Margaree River during 1991 to 2010. Parr include juveniles of age one and older.

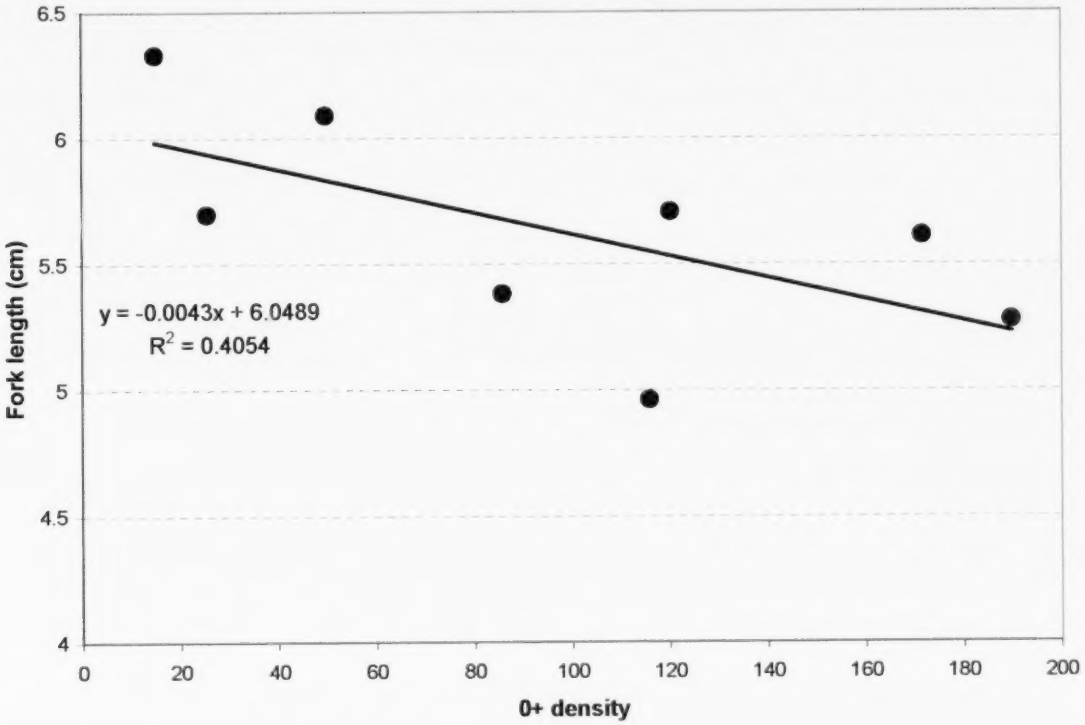

Figure 16. Average fork length (cm) of fry in relation to the average fry density in the Margaree River for years 2004 to 2011.

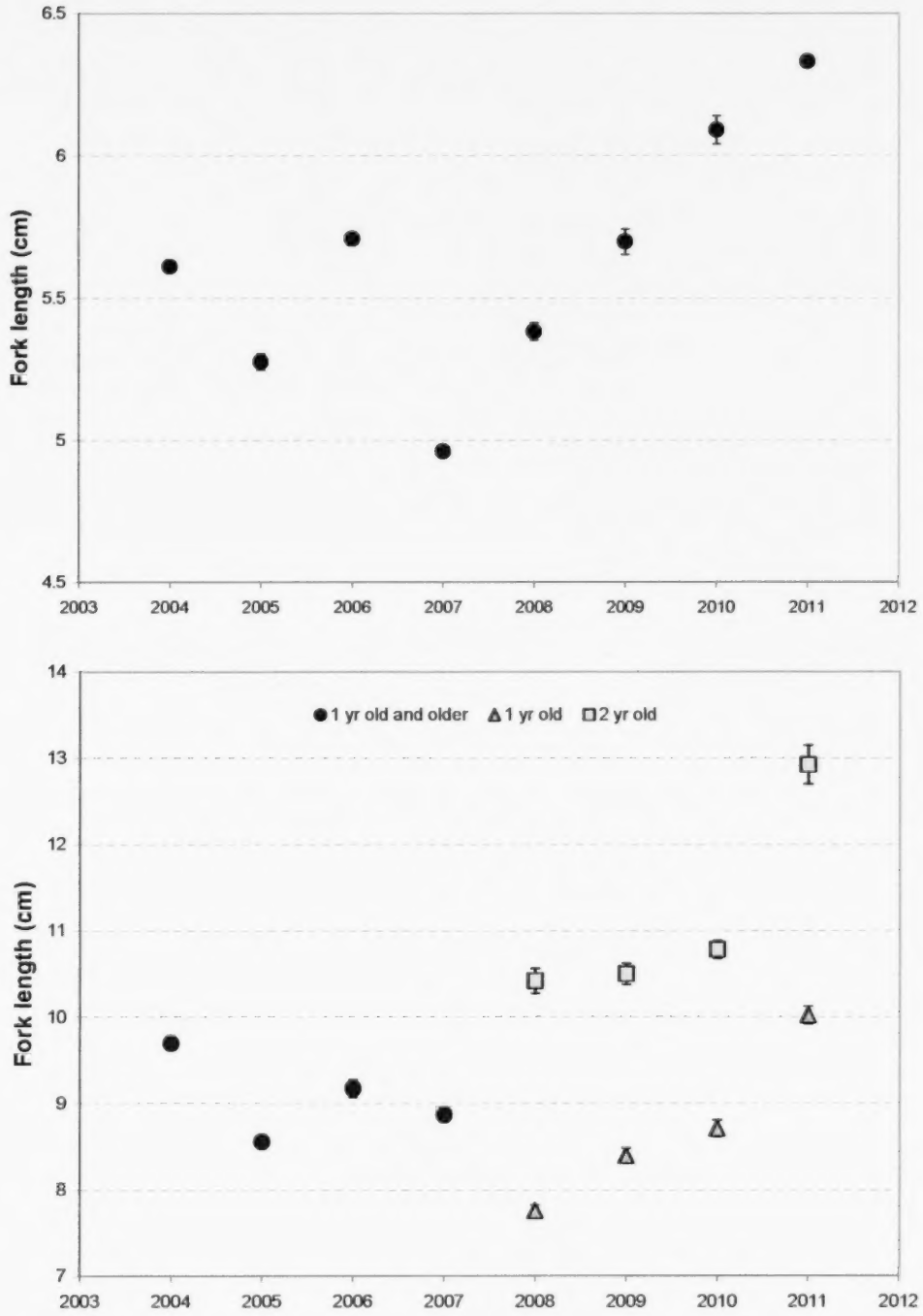

Figure 17. Fork length (cm) of fry (upper panel) and parr (lower panel) in the Margaree River during 2004 to 2011.

Appendix 1. Angling catch data for the Margaree and Mabou rivers (Inverness County) of SFA 18B, 1984 to 2011. Small salmon catch includes small salmon kept and released. The 5-year average includes 2006-2010. Data for 2011 are preliminary. Data are adjusted for incomplete reporting.

	Margaree River				Mabou River			
Year	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released
1984	6,410	196	246	296	1	0	0	0
1985	7,775	399	508	1,206	0	0	0	0
1986	10,172	651	783	2,632	13	3	3	19
1987	12,773	822	972	1,847	1	0	0	0
1988	14,136	771	901	1,979	5	0	0	0
1989	13,241	444	574	1,607	0	0	0	0
1990	14,062	502	655	1,520	16	0	0	0
1991	13,407	575	773	1,808	9	3	3	3
1992	15,016	568	699	1,999	26	3	10	23
1993	15,575	556	769	1,090	12	2	2	3
1994	13,534	290	427	1,478	31	3	3	1
1995	12,336	205	343	1,091	8	2	3	1
1996	9,224	284	1,239	1,938	21	6	7	6
1997	9,827	195	311	2,105	11	0	0	2
1998	10,129	209	352	1,341	20	3	3	5
1999	7,843	197	311	808	16	3	3	4
2000	7,351	133	262	696	16	4	8	6
2001	7,521	142	364	854	20	4	4	3
2002	7,359	161	363	611	13	2	2	6
2003	7,398	184	327	1,138	18	3	3	4
2004	7,896	251	518	1,408	11	2	3	2
2005	9,382	206	418	1,340	26	9	12	16
2006	9,088	253	444	1,256	27	5	10	9
2007	8,675	186	341	784	39	1	2	1
2008	8,658	331	684	1,391	14	0	2	0
2009	8,274	50	171	1,023	58	3	3	10
2010	7,207	182	426	1,227	110	0	7	23
2011	9,945	240	686	2,865	62	9	9	12
5-yr average (2006-2010)	8,380	200	413	1,136	50	2	5	9

Appendix 2. Angling catch data for West and South rivers (Antigonish County) in SFA 18A, 1984 to 2011. Small salmon catch includes small salmon kept and released. The 5-year average includes 2006-2010. Data for 2011 are preliminary. Data are adjusted for incomplete reporting.

	West River				South River			
	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released
1984	103	16	18	2	103	16	18	2
1985	224	25	34	121	224	25	34	121
1986	521	84	124	468	521	84	124	468
1987	734	58	84	197	734	58	84	197
1988	472	36	68	140	472	36	68	140
1989	525	67	91	222	525	67	91	222
1990	698	88	150	198	698	88	150	198
1991	731	38	63	277	731	38	63	277
1992	753	80	144	293	753	80	144	293
1993	911	40	69	261	911	40	69	261
1994	769	29	43	127	769	29	43	127
1995	612	48	81	137	612	48	81	137
1996	1034	118	305	513	1034	118	305	513
1997	277	22	43	90	277	22	43	90
1998	885	58	123	168	885	58	123	168
1999	879	78	167	232	879	78	167	232
2000	678	32	97	134	678	32	97	134
2001	153	0	12	20	153	0	12	20
2002	591	32	107	81	591	32	107	81
2003	444	16	53	136	444	16	53	136
2004	549	26	79	125	549	26	79	125
2005	629	17	105	194	629	17	105	194
2006	870	22	118	179	870	22	118	179
2007	542	19	102	55	549	19	88	43
2008	497	9	56	60	51	2	22	7
2009	619	0	42	107	52	0	3	6
2010	773	9	100	222	91	7	19	9
2011	951	22	207	435	173	0	34	40
5-yr average (2006-2010)	660	12	84	125	323	10	50	49

Appendix 3. Angling catch data for the East, Middle and West rivers (Pictou County) in SFA 18A, 1984 to 2011. Small salmon catch includes small salmon kept and released. No angling activity reported in years with empty cells. The 5-year average includes 2006-2010. Data for 2011 are preliminary. Data are adjusted for incomplete reporting.

	East River				Middle River				West River			
Year	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released
1984	455	13	15	41	0	0	0	0	1	0	0	0
1985	396	25	41	161	1	0	0	0	31	2	2	4
1986	1,144	71	89	616	0	0	0	0	38	3	4	4
1987	1,275	63	82	388	2	0	0	3	245	15	15	26
1988	1,309	100	135	443	0	0	0	0	314	23	25	43
1989	1,706	42	89	687	0	0	0	0	425	13	15	61
1990	1,393	81	106	292	0	0	0	0	251	32	38	42
1991	1,522	77	123	448	4	0	0	1	640	35	45	152
1992	974	64	115	386	0	0	0	0	415	25	32	129
1993	1,063	35	57	227	2	0	1	0	608	32	42	168
1994	627	15	24	93	0	0	0	0	249	3	5	17
1995	460	21	37	47	0	0	0	0	466	27	37	39
1996	819	34	75	280	0	0	0	0	767	57	87	193
1997	417	24	36	67	0	0	0	0	205	5	9	27
1998	678	25	47	106	5	0	0	0	518	30	36	102
1999	652	24	54	168	3	0	0	0	591	28	64	168
2000	433	11	25	29	0	0	0	0	398	16	26	32
2001	119	8	12	11	0	0	0	0	122	0	0	7
2002	414	5	31	56	3	0	2	0	558	19	40	37
2003	312	4	14	29	6	0	0	0	280	5	15	48
2004	384	17	38	67	0	0	0	0	342	24	50	31
2005	313	24	57	67	1	0	0	0	427	13	34	69
2006	443	10	29	121	5	0	0	0	400	22	34	56
2007	542	18	54	68	0	0	0	0	295	16	24	22
2008	389	13	60	101	2	0	0	0	300	16	36	25
2009	811	6	41	276	.	.	.	.	477	8	28	105
2010	771	5	45	166	.	.	.	.	409	23	56	82
2011	911	19	81	275	.	.	.	.	676	25	90	198
5-yr average (2006-2010)	591	10	46	146					376	17	36	58

Appendix 4. Angling catch data for River John, the Sutherland and Barney's rivers (Pictou County) in SFA 18A, 1984 to 2011. Small salmon catch includes small salmon kept and released. No angling activity reported in years with empty cells. The 5-year average includes 2006-2010. Data for 2011 are preliminary. Data are adjusted for incomplete reporting.

	River John				Sutherland River				Barney's River			
Year	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released
1984	22	1	1	0					0	0	0	0
1985	58	1	2	58	3	0	0	4	0	0	0	0
1986	187	29	30	152	2	0	0	0	0	0	0	0
1987	235	21	24	70	6	2	4	7	0	0	0	0
1988	258	40	53	121	0	0	0	0	6	1	1	8
1989	267	17	18	99	0	0	0	0	11	1	6	1
1990	302	52	66	44	0	0	0	0	23	7	7	5
1991	200	28	34	81	3	0	0	0	18	1	1	4
1992	167	11	17	77	9	2	2	1	102	7	11	11
1993	234	14	22	73	25	0	0	0	26	1	1	1
1994	185	11	13	34	0	0	0	0	53	0	0	3
1995	122	10	12	17	3	1	1	0	5	1	1	0
1996	276	21	33	118	3	0	0	0	30	11	14	10
1997	210	23	24	52	0	0	0	0	9	0	0	0
1998	209	19	44	37	9	0	1	0	21	0	0	1
1999	231	17	23	56	0	0	0	0	11	0	0	4
2000	169	6	8	10	6	0	0	0	4	0	0	0
2001	25	0	0	0	0	0	0	0	0	0	0	0
2002	104	5	8	5	4	0	0	0	3	0	0	0
2003	70	0	0	0	1	0	0	0	3	0	0	0
2004	151	19	26	34	2	0	0	0	0	0	0	0
2005	126	11	21	87	9	1	3	1	13	0	1	4
2006	95	5	8	18	3	0	2	0	8	0	0	2
2007	112	7	19	23	7	0	1	1	7	1	1	1
2008	98	9	27	18	.	.	.	.	9	0	0	0
2009	105	0	25	69	10	0	0	0	52	0	3	6
2010	115	9	16	21	14	2	4	2	61	0	5	7
2011	247	9	52	157	19	0	3	12	232	0	28	52
5-yr average (2006-2010)	105	6	19	30	9	1	2	1	27	0	2	3

Appendix 5. Angling catch data for the French River and Waugh River (Colchester County) in SFA 18A, 1984 to 2011. Small salmon catch includes small salmon kept and released. The 5-year average includes 2006-2010. Data for 2011 are preliminary. Data are adjusted for incomplete reporting.

	French River				Waugh River			
Year	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released
1984	0	0	0	0	8	0	0	0
1985	0	0	0	0	5	0	0	1
1986	7	0	0	0	33	6	9	28
1987	2	0	0	0	47	0	0	7
1988	6	0	0	2	74	5	11	26
1989	1	0	0	0	92	5	5	5
1990	13	0	1	1	98	14	15	15
1991	26	7	8	7	270	14	19	108
1992	17	0	0	0	123	10	13	18
1993	23	0	0	7	201	13	19	42
1994	22	0	0	0	102	6	15	30
1995	17	1	1	1	218	13	21	36
1996	39	1	1	14	450	25	29	141
1997	21	3	6	6	127	7	13	11
1998	20	1	1	1	254	15	28	45
1999	6	2	2	2	153	10	16	26
2000	4	0	0	0	163	11	13	8
2001	0	0	0	0	76	0	2	0
2002	3	0	0	0	146	7	10	7
2003	4	0	0	0	152	2	2	20
2004	9	0	2	2	149	3	15	41
2005	5	0	0	1	160	3	7	30
2006	8	0	0	8	112	1	2	7
2007	27	0	3	3	141	2	11	25
2008	20	2	4	7	150	0	11	29
2009	55	0	0	0	175	0	6	19
2010	35	2	4	0	131	2	7	23
2011	62	0	9	19	408	9	34	244
5-yr average (2006-2010)	29	1	2	4	142	1	7	21

Appendix 6. Angling catch data for the Shinimikas River, River Philip and Wallace River (Cumberland County) in SFA 18A, 1984 to 2011. Small salmon catch includes small salmon kept and released. No angling activity reported in years with empty cells. The 5-year average includes 2006-2010. Data for 2011 are preliminary. Data are adjusted for incomplete reporting.

	Shinimikas River				River Philip				Wallace River			
YEAR	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released	Effort - rod days	Grilse kept	Grilse catch	Salmon released
1984	0	0	0	0	297	23	25	57	52	1	1	4
1985	2	0	0	0	309	11	12	69	85	3	5	16
1986	0	0	0	0	636	87	111	337	232	15	16	115
1987	4	0	2	1	1,108	66	76	338	282	9	11	49
1988	0	0	0	0	1,235	154	176	342	297	14	17	35
1989	4	0	0	0	1,249	93	113	403	239	10	13	34
1990	0	0	0	0	1,137	126	157	193	258	11	16	33
1991	0	0	0	0	1,469	107	161	412	399	25	39	88
1992	0	0	0	0	1,221	169	184	332	428	19	31	91
1993	0	0	0	0	1,677	107	166	336	847	20	33	109
1994	0	0	0	0	1,210	62	88	179	487	11	22	56
1995	1	0	0	0	1,506	105	138	234	617	19	32	30
1996	0	0	0	0	1,845	181	260	722	453	21	27	93
1997	0	0	0	0	713	38	43	90	389	13	39	105
1998	0	0	0	0	1,282	86	119	248	358	29	41	60
1999	0	0	0	0	1,142	101	146	300	343	11	23	67
2000	1	0	0	0	936	41	63	115	297	12	22	22
2001	1	0	0	0	340	4	13	17	141	3	7	4
2002	16	1	1	0	922	42	89	59	336	15	29	25
2003	0	0	0	0	661	45	86	88	340	10	15	31
2004	0	0	0	0	896	62	145	166	345	26	46	63
2005	0	0	0	0	998	45	111	167	300	5	36	47
2006	0	0	0	0	1,164	29	54	138	468	11	29	70
2007	1	0	0	0	948	12	40	33	380	8	13	24
2008	.	.	.	.	901	14	45	34	313	11	2	25
2009	.	.	.	.	1,050	0	29	62	489	13	88	101
2010	.	.	.	.	1,028	21	79	115	561	42	79	37
2011	.	.	.	.	1,547	105	371	266	658	19	75	315
5-yr average (2006-2010)					1,018	15	49	76	442	17	42	51

Appendix 7. The minimum and maximum estimates of small salmon and large salmon returns and spawners for the Margaree River, 1984 to 2011. Estimates of returns for 1987 to 2011 are based on 95% credibility interval range from the Bayesian catch rate model (Breau and Chaput 2012). See Breau et al. 2009 for years 1970 to 1983.

Year	Small salmon				Large salmon			
	Returns		Spawners		Returns		Spawners	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1984	400	688	154	442	327	583	312	568
1985	634	1,167	126	659	1,109	2,217	1,049	2,157
1986	838	1,420	55	637	2,738	5,680	2,606	5,548
1987	1,353	1,959	381	987	3,245	4,310	3,153	4,218
1988	1,126	1,651	225	750	3,152	4,212	3,053	4,113
1989	728	1,090	154	516	2,614	3,518	2,534	3,438
1990	812	1,217	157	562	2,375	3,197	2,299	3,121
1991	945	1,416	172	643	2,942	4,000	2,852	3,910
1992	819	1,214	120	515	3,001	4,019	2,901	3,919
1993	947	1,340	178	571	1,669	2,193	1,615	2,139
1994	544	817	117	390	2,502	3,392	2,428	3,318
1995	441	674	98	331	1,880	2,565	1,825	2,510
1996	1,960	3,041	721	1,802	4,070	5,605	3,973	5,508
1997	452	717	141	406	4,286	5,918	4,181	5,813
1998	510	809	158	457	2,585	3,578	2,518	3,511
1999	565	904	254	593	1,948	2,720	1,908	2,680
2000	494	814	232	552	1,830	2,604	1,795	2,569
2001	659	1,074	295	710	2,127	3,014	2,084	2,971
2002	681	1,117	318	754	1,528	2,190	1,497	2,159
2003	618	1,029	291	702	2,990	4,246	2,933	4,189
2004	871	1,452	353	934	3,315	4,733	3,245	4,663
2005	633	1,009	215	591	2,762	3,845	2,695	3,778
2006	696	1,139	252	695	2,653	3,743	2,590	3,680
2007	579	970	238	629	1,837	2,643	1,798	2,604
2008	1,036	1,777	352	1,093	2,530	3,677	2,460	3,607
2009	241	470	70	299	1,915	2,850	1,864	2,799
2010	729	1286	303	860	2,590	3,800	2,529	3,739
2011	856	1,488	170	802	4,357	6,294	4,214	6,151

Appendix 8. Minimum and maximum estimates of small salmon, large salmon and 2SW salmon returns and spawners for SFA 18, 1984 to 2011.

Year	Small salmon				Large Salmon				2SW Salmon			
	Returns		Spawners		Returns		Spawners		Returns		Spawners	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1984	460	1,867	177	1,200	3,105	4,107	337	1,320	2,391	3,573	259	1,148
1985	730	3,167	145	1,788	1,196	5,150	1,131	5,010	921	4,481	871	4,359
1986	965	3,854	63	1,729	2,953	13,195	2,811	12,889	2,274	11,479	2,164	11,213
1987	1,557	5,316	439	2,679	3,500	10,012	3,400	9,798	2,695	8,711	2,618	8,524
1988	1,296	4,481	259	2,035	3,399	9,785	3,293	9,555	2,617	8,513	2,535	8,313
1989	838	2,958	178	1,400	2,819	8,172	2,732	7,986	2,171	7,110	2,104	6,948
1990	934	3,303	180	1,525	2,561	7,427	2,479	7,250	1,972	6,461	1,909	6,308
1991	1,088	3,843	198	1,745	3,173	9,292	3,075	9,082	2,443	8,084	2,368	7,901
1992	943	3,295	139	1,398	3,236	9,336	3,129	9,104	2,492	8,123	2,409	7,921
1993	1,090	3,637	205	1,550	1,800	5,094	1,741	4,968	1,386	4,432	1,341	4,322
1994	626	2,217	134	1,059	2,698	7,880	2,619	7,708	2,078	6,855	2,016	6,706
1995	508	1,829	113	898	2,027	5,959	1,969	5,832	1,561	5,184	1,516	5,074
1996	2,256	8,253	830	4,890	4,389	13,021	4,285	12,795	3,380	11,328	3,299	11,132
1997	521	1,947	163	1,103	4,622	13,748	4,509	13,503	3,559	11,960	3,472	11,748
1998	587	2,195	181	1,240	2,788	8,312	2,715	8,156	2,147	7,231	2,091	7,096
1999	651	2,454	293	1,610	2,101	6,319	2,057	6,225	1,618	5,497	1,584	5,416
2000	569	2,209	267	1,498	1,974	6,049	1,936	5,968	1,520	5,263	1,491	5,192
2001	758	2,915	339	1,927	2,294	7,002	2,248	6,902	1,766	6,091	1,731	6,005
2002	783	3,031	366	2,046	1,648	5,087	1,615	5,016	1,269	4,426	1,243	4,364
2003	711	2,793	335	1,905	3,225	9,864	3,163	9,731	2,483	8,581	2,436	8,466
2004	1,002	3,940	406	2,535	3,575	10,995	3,499	10,831	2,753	9,566	2,694	9,423
2005	729	2,738	248	1,604	2,979	8,932	2,906	8,776	2,294	7,771	2,238	7,635
2006	801	3,091	290	1,886	2,861	8,695	2,793	8,549	2,203	7,565	2,151	7,438
2007	666	2,632	274	1,707	1,981	6,140	1,939	6,049	1,525	5,342	1,493	5,262
2008	1,193	4,822	405	2,966	2,728	8,542	2,653	8,380	2,101	7,431	2,043	7,291
2009	277	1,274	80	810	2,065	6,621	2,010	6,502	1,590	5,760	1,548	5,657
2010	840	3,490	349	2,334	2,793	8,827	2,727	8,685	2,151	7,680	2,100	7,556
2011	986	4,038	196	2,176	4,699	14,621	4,544	14,288	3,618	12,720	3,499	12,431